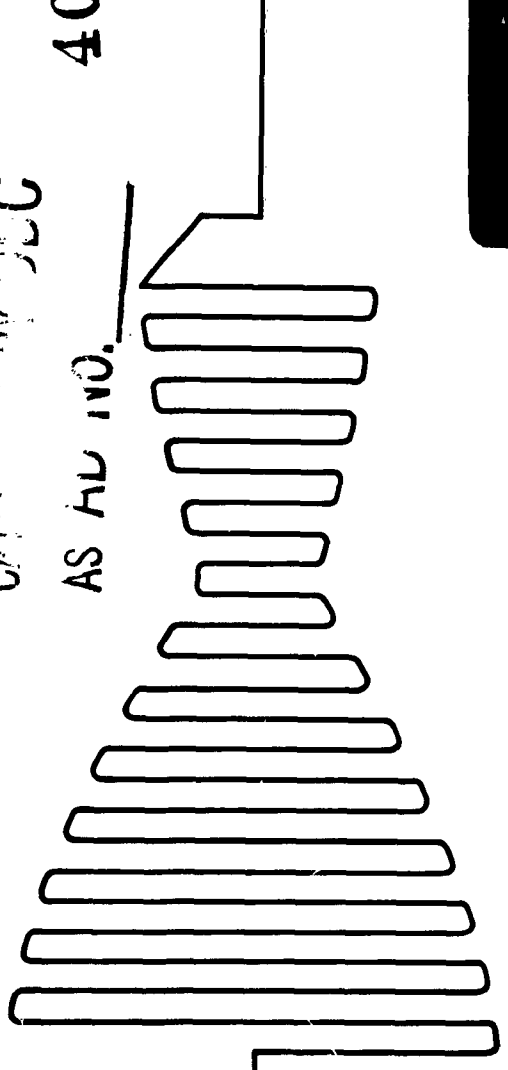
63-4-2



ROCKETDYNE

A DIVISION OF NORTH AMERICAN AVIATION, INC.

CANOGA PARK, CALIFORNIA

409 534

FOR ERRATA

AD 409534

THE FOLLOWING PAGES ARE CHANGES

TO BASIC DOCUMENT

ROCKETDYNE • A DIVISION OF NORTH AMERICAN AVIATION INC

As of 22 July 1964

SPECIFICATION CHANGE INDEX

Specification No. R-3953S

SCN No.	MA5 ECP No.	SCN Date	Pages Affected	Item Affected YLR101-NA-15 MD Ident. No.	Subject
1	92R1	25 March 1964	1,6,7,12, 14,68,69, 70,71	1	Provisions for YLR101-NA-15 Vernier Engine Thrust-level Increase.
2	99R1	25 March 1964	1,6,7,11, 14,55,68, 69,70,71	2	Replacement of YLR101-NA-15 Vernier Engine Thrust Chamber Injector Assembly.
ø 3	102R1	10 June 1964	14	3	Addition of YLR101-NA-15 Vernier Engine Torque Striping.

ø Item added this issue

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION INC

SPECIFICATION CHANGE NOTICE

Number 3

SECURITY CLASSIFICATION: UNCLASSIFIED [X] CONFIDENTIAL [ ] SECRET [ ]

Page 1 of 1

Date 10 June 1964

SUPERSEDES Date

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3. SPECIFICATION NO.
NA-MA5-102R1	Rocketdyne Liquid-Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S
4. CONTRACT	**5. CONTRACTUAL AUTHORIZATION**	**FILE OPPOSITE SPEC. PAGE NO.**
L/C AF04(695)-500	CCN6 (N500-SSD65MSN-53)	14

6. PRODUCTION EFFECTIVITY:

NA336589 and subsequent.

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

Paragraph 3.5 Drawings and Data

Change YLR101-NA-15 MD number identification to incorporate MD3.

Form 608-B-8

1 May 1964

AD 409534

SPECIFICATION CHANGE INDEX

Specification No. R-3953S

SCN No.	MA5-ECP No.	SCN Date	Pages Affected	Item Affected YLR101-NA-15 MD Ident. No.	Subject
Ø 1	92R1	25 March 1964	1,6,7,12, 14,68,69, 70, 71	1	Provisions for YLR101-NA-15 Vernier Engine Thrust-level Increase.
Ø 2	99R1	25 March 1964	1,6,7,11 14,55,68, 69,70, 71	2	Replacement of YLR101-NA-15 Vernier Engine Thrust Chamber Injector Assembly

Ø Denotes changes to the Specification Change Index.

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC

SPECIFICATION CHANGE NOTICE

Number 1

SECURITY CLASSIFICATION: UNCLASSIFIED [X] CONFIDENTIAL [ ] SECRET [ ]

Page 1 of 6

Date 25 March 1964

SUPERSEDES Date 18 June 1963

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3. SPECIFICATION NO.
NA-MA5-92R1	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S
4. CONTRACT	**5. CONTRACTUAL AUTHORIZATION**	**FILE OPPOSITE SPEC. PAGE NO** 1
AF04(694)-58	CCN50(N58-64MSN-26) CCN64(N58-64MSN-2149)	Other pages affected: 5,6,11,14,68,69,70 & 71

6. PRODUCTION EFFECTIVITY:

NA336501 through NA336510 and NA336577 through NA336584 only.

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

Paragraph 1.2 Classification

Change "525 pounds" to read "777 pounds."

NOTE: Attachments I through IV issued with SCN 1 dated 18 June 1963 are to be retained for use with SCN1 dated 25 March 1964.

Form 608-8-8

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.

SPECIFICATION CHANGE NOTICE

Number 1

SECURITY CLASSIFICATION: UNCLASSIFIED [X] CONFIDENTIAL [ ] SECRET [ ]

Date 25 March 1964

SUPERSEDES Date 18 June 1963

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3 SPECIFICATION NO
NA-MA5-92R1	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S
4. CONTRACT	5. CONTRACTUAL AUTHORIZATION	FILE OPPOSITE SPEC PAGE NO 5
AF04(694)-58	CCN50(N58-64MSN-26) CCN64(N58-64MSN-2149)	Other pages affected: 1,6,11,14,68,69,70 & 71

6. PRODUCTION EFFECTIVITY:

NA336501 through NA336510 and NA336577 through NA336584 only.

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

Paragraph 3.3.3 Estimates

1. Change "Fuel pressure 529 psia" to read "Fuel pressure 678 psia."

2. Change "LOX pressure 504 psia" to read "LOX pressure 646 psia."

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC

SPECIFICATION CHANGE NOTICE

Number 1

SECURITY CLASSIFICATION: UNCLASSIFIED [X] CONFIDENTIAL [ ] SECRET [ ]

Date 25 March 1964

SUPERSEDES Date 18 June 1963

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3 SPECIFICATION NO
NA-MA5-92R1	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S

4. CONTRACT	5. CONTRACTUAL AUTHORIZATION	FILE OPPOSITE SPEC PAGE NO 6
AF04(694)-58	CCN50(N58-64MSN-26) CCN64(N58-64MSN-2149)	Other pages affected: 1, 5,11,14,68,69,70 & 71

6. PRODUCTION EFFECTIVITY:

NA336501 through NA336510 and NA336577 through NA336584 only.

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

Table I YLR101-NA-15 Rating at standard sea level static conditions

Change Table I to read as follows:

Engine	Engine Thrust lbs. (a)	Engine instantaneous specific impulse seconds, min. (b)	Engine altitude (0 psia ambient) specific impulse, seconds, calculated min. (b)	Engine altitude (0 psia ambient) thrust pounds calculated minimum	Nominal chamber pressure psia	Engine mixture ratio O/F	Engine inlet pressures, psia	
							Fuel	Oxidizer
YLR101-NA-15 Tank-fed	802 max. 777 752 Min.	187	228	925	282	1.80±4%	543	543
(c) Pump-Fed	909	192	241	1081	322	1.72	678	646

(a) Engine thrust considered parallel to thrust chamber axis. The engine thrust values are corrected to rated engine inlet conditions.

(b) The average specific impulse of an individual engine, corrected to rated thrust, mixture ratio, and engine inlet conditions, shall be equal to or greater than the minimum specified.

(c) The pump-fed ratings are estimated at nominal conditions and are for reference only.

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC

SPECIFICATION CHANGE NOTICE

Number 1

SECURITY CLASSIFICATION: UNCLASSIFIED [X] CONFIDENTIAL [ ] SECRET [ ]

Page 4 of 6

Date 25 March 1964

SUPERSEDES Date 18 June 1963

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3. SPECIFICATION NO.
NA-MA5-92R1	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S
4. CONTRACT	**5. CONTRACTUAL AUTHORIZATION**	**FILE OPPOSITE SPEC. PAGE NO 11**
AF04(694)-58	CCN50(N58-64MSN-26) CCN64(N58-64MSN-2149)	Other pages affected: 1, 5,6,11,14,68,69,70, & 71

6. PRODUCTION EFFECTIVITY:

NA336501 through NA336510 and NA336577 through NA336584 only.

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

Paragraph 3.3.10.2.3 Decrease

Change the tabulated information to read as follows:

Delay circuit inactive	Delay circuit active
min. 182 lb-sec	min. 111 lb-sec
max. 132 lb-sec	max. 189 lb-sec

Form 608-8-8

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC

SPECIFICATION CHANGE NOTICE

Number 1

SECURITY CLASSIFICATION
- UNCLASSIFIED [X]
- CONFIDENTIAL [ ]
- SECRET [ ]

Date 25 March 1964

SUPERSEDES Date 18 June 1964

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3. SPECIFICATION NO.
NA-MA5-92R1	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S

4. CONTRACT	5. CONTRACTUAL AUTHORIZATION	FILE OPPOSITE SPEC PAGE NO 14
AF04(694)-58	CCN50(N58-64MSN-26) CCN64(N58-64MSN-2149)	Other pages affected: 1,5,6,11,68,69,70 & 71

6. PRODUCTION EFFECTIVITY:

NA336501 through NA336510 and NA336577 through NA336584 only

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

Paragraph 3.5 Drawings and data

Change YLR101-NA-15 MD Number Identification to incorporate MD1.

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.

SPECIFICATION CHANGE NOTICE

Number 1

SECURITY CLASSIFICATION: UNCLASSIFIED [X] CONFIDENTIAL [ ] SECRET [ ]

Page 6 of 6

Date 25 March 1964

SUPERSEDES Date 18 June 1963

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3. SPECIFICATION NO
NA-MA5-92R1	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S

4. CONTRACT	5. CONTRACTUAL AUTHORIZATION	FILE OPPOSITE SPEC PAGE NO
AF04(694)-58	CCN50(N58-64MSN-26) CCN64(N58-64MSN-2149)	68 and as noted. Other pages affected: 1, 5,6,11,14,69,70 & 71

6. PRODUCTION EFFECTIVITY:

NA336501 through NA336510 and NA336577 through NA336584 only.

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

As Noted

Page 68	Figure 1	Attachment I
69	2	II
70	3	III
71	4	IV

NOTE: Figures 1 through 4 which were issued as Attachments I through IV to SCN1 dated 18 June 1963 are to be retained for use with SCN1 (revised) dated 25 March 1964.

Form 608-8-8

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION INC

SPECIFICATION CHANGE NOTICE

Number 2

SECURITY CLASSIFICATION: UNCLASSIFIED [X] CONFIDENTIAL [ ] SECRET [ ]

Page 1 of 7

Date 25 March 1964

SUPERSEDES Date 16 September 1963

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3. SPECIFICATION NO.
NA-MA5-99R1	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S
4. CONTRACT	**5. CONTRACTUAL AUTHORIZATION**	**FILE OPPOSITE SPEC. PAGE NO** 1
AF04(694)-58	CCN63(N58-64MSN-2148)	Other pages affected: 6,7,11,14,55,68,69 & 71

6. PRODUCTION EFFECTIVITY:

NA336511 through NA336576, and NA336585 and subsequent.

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

Paragraph 1.2 Classification

Change the first sentence to read:

The rocket engine is a calibrated, fixed-thrust bipropellant rocket engine with a nominal sea-level pump-fed rating of 669 pounds.

NOTE: Attachments I through III issued with SCN2 dated 16 September 1963 are to be retained for use with SCN2 dated 25 March 1964.

Form 608-8-8

AD 409534

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION INC

SPECIFICATION CHANGE NOTICE

Number 2

SECURITY CLASSIFICATION: UNCLASSIFIED [X] CONFIDENTIAL [ ] SECRET [ ]

Date 25 March 1964

SUPERSEDES Date 16 September 1963

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3 SPECIFICATION NO.
NA-MA5-99R1	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S
4. CONTRACT	**5. CONTRACTUAL AUTHORIZATION**	**FILE OPPOSITE SPEC. PAGE NO 6**
AF04(694)-58	CCN63(N58-64MSN-2148)	Other pages affected: 1,7,11,14,55,68,69 & 71

6. PRODUCTION EFFECTIVITY:

NA336511 through NA336576, and NA336585 and subsequent.

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

Paragraph 3.3.3 Estimates

1. Change "Fuel pressure 529 psia" to read "Fuel pressure 448 psia."

2. Change "LOX pressure 504 psia" to read "LOX pressure 509 psia."

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.

SPECIFICATION CHANGE NOTICE

Number 2

SECURITY CLASSIFICATION: UNCLASSIFIED [X] CONFIDENTIAL [ ] SECRET [ ]

Page 3 of 7

Date 25 March 1964

SUPERSEDES Date 16 September 1963

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3. SPECIFICATION NO
NA-MA5-99R1	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S

4. CONTRACT	5. CONTRACTUAL AUTHORIZATION	FILE OPPOSITE SPEC PAGE NO 7
AF04(694)-58	CCN63(N58-64MSN-2148)	Other pages affected: 1,6,11,14,55,68,69 & 71

6. PRODUCTION EFFECTIVITY:

NA336511 through NA336576, and NA336585 and subsequent

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

Table I YLR101-NA-15 Rating at standard sea-level static conditions

Change Table I to read as follows:

Engine Thrust lbs (a)	Engine instantaneous specific impulse, seconds, min. (b)	Engine altitude (0 psia ambient) specific impulse, seconds, calculated min. (b)	Engine altitude (0 psia ambient) thrust pounds, calculated minimum	Nominal chamber pressure, psia	Engine mixture ratio O/F	Engine inlet pressures, psia Fuel	Oxidizer
(c) Tank-Fed 525	171	221	698	207	1.80	335	390
699 Max Pump-Fed 639 Min	180	226	811	250	1.72 ± 4%	448	509

(a) Engine thrust considered parallel to thrust chamber axis. The engine thrust values are corrected to rated engine inlet conditions.

(b) The average pump-fed specific impulse of an individual engine, corrected to rated thrust, mixture ratio, and engine inlet conditions, shall be equal to or greater than the minimum specified.

(c) The tank-fed ratings are estimated and are for reference only.

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.

SPECIFICATION CHANGE NOTICE

Number 2

SECURITY CLASSIFICATION: UNCLASSIFIED [X] CONFIDENTIAL [ ] SECRET [ ]

Page 4 of 7

Date 25 March 1964

SUPERSEDES Date 16 September 1963

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3 SPECIFICATION NO.
NA-MA5-99R1	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-39538

4. CONTRACT	5. CONTRACTUAL AUTHORIZATION	FILE OPPOSITE SPEC PAGE NO 11
AF04(694)-58	CCN63(N58-64MSN-2148)	Other pages affected: 1,6,7,14,55,68,69 & 71

6. PRODUCTION EFFECTIVITY:

NA336511 through NA336576, and NA336585 and subsequent.

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

Paragraph 3.3 10.1.1 Mixture ratio

Change the paragraph to read:

The mixture ratio shall be controlled within safe operating limits during mainstage operation and during thrust increase and decrease. The safe operating mixture ratio limits are specified as 1.6 to 1.95.

(1) Pump-fed operation: The YLR101-NA-15 mixture ratio is dependent upon the YLR105-NA-7 rated performance.

(2) Tank-fed operation: Nominal mixture ratio shall be as specified in Table I.

Paragraph 3.3 10.2 Thrust

Change the paragraph to read:

There are no intermediate controlled-thrust settings.

(1) Pump-fed operation: The thrust limits specified in Table I are dependent upon the YLR105-NA-7 rated performance.

(2) Tank-fed operation: Nominal thrust shall be as specified in Table I.

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.

SPECIFICATION CHANGE NOTICE

Number 2

SECURITY CLASSIFICATION
UNCLASSIFIED [X]
CONFIDENTIAL [ ]
SECRET [ ]

Page 5 of 7

Date 25 March 1964

SUPERSEDES Date 16 September 1963

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3 SPECIFICATION NO
NA-MA5-99R1	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S

4. CONTRACT	5. CONTRACTUAL AUTHORIZATION	FILE OPPOSITE SPEC PAGE NO 14
AF04(694)-58	CCN63(N58-64MSN-2148)	Other pages affected: 1,6,7,11,55,68,69 & 71

6. PRODUCTION EFFECTIVITY:

NA336511 through NA336576, and NA336585 and subsequent

7 EFFECT OF CHANGE ON SPECIFICATION CONTENT:

Paragraph 3 5 Drawing and data

Change YLR101-NA-15 MD Number Identification to incorporate MD2.

Form 608-B-8

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.

SPECIFICATION CHANGE NOTICE

Number 2

SECURITY CLASSIFICATION: UNCLASSIFIED [X] CONFIDENTIAL [ ] SECRET [ ]

Page 6 of 7

Date 25 March 1964

SUPERSEDES Date 16 September 1963

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3 SPECIFICATION NO
NA-MA5-99R1	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S

4. CONTRACT	5. CONTRACTUAL AUTHORIZATION	FILE OPPOSITE SPEC PAGE NO 55
AF04(694)-58	CCN63(N58-64MSN-2148)	Other pages affected: 1,6,7,11,14,68,69, & 71

6. PRODUCTION EFFECTIVITY:

NA336511 through NA336576, and NA336585 and subsequent.

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

Paragraph 4.2.4 (5152)

Change "tank-fed" to read "pump-fed" in lines two and eight

Change last sentence to read "The tank-fed ratings, except cutoff impulse shall not be demonstrated or reported."

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.

SPECIFICATION CHANGE NOTICE

Number 2

SECURITY CLASSIFICATION: UNCLASSIFIED [X] CONFIDENTIAL [ ] SECRET [ ]

Page 7 of 7

Date 25 March 1964

SUPERSEDES Date 16 September 1963

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3 SPECIFICATION NO
NA-MA5-99R1	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-39538

4. CONTRACT	5. CONTRACTUAL AUTHORIZATION	FILE OPPOSITE SPEC PAGE NO
AF04(694)-58	CCN63(N58-64MSN-2148)	68 & as noted. Other pages affected 1,6,7,11,14,55,69 & 71

6. PRODUCTION EFFECTIVITY:

NA336511 through NA336576, and NA336585 and subsequent.

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

As noted

Page	68	Figure 1	Attachment I
	69	2	II
	71	4	III

NOTE: Figures 1, 2, and 4 which were issued as Attachments I through III to SCN2 dated 16 September 1963 are to be retained for use with SCN2 (revised) dated 25 March 1964

Form 608-B-8

FOR ERRATA

AD 409534

THE FOLLOWING PAGES ARE CHANGES

TO BASIC DOCUMENT

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.

SPECIFICATION CHANGE NOTICE

Number 2

SECURITY CLASSIFICATION: UNCLASSIFIED [X] CONFIDENTIAL [ ] SECRET [ ]

Page 1 of 7

Date 16 September 1963

SUPERSEDES Date

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3. SPECIFICATION NO.
NA-MA5-99	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S
4. CONTRACT	**5. CONTRACTUAL AUTHORIZATION**	**FILE OPPOSITE SPEC. PAGE NO. 1**
AF04(694)-58	CCN 56 (N58-639)	Other pages affected: 6, 7,11,14,55,68,69 and 71

6. PRODUCTION EFFECTIVITY:

NA 336511 and subsequent.

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

Paragraph 1.2 Classification

Change the first sentence to read:

The rocket engine is a calibrated, fixed-thrust bipropellant rocket engine with a nominal sea-level pump-fed rating of 669 pounds.

m 608-8-8

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.

SPECIFICATION CHANGE NOTICE

Number 2

SECURITY CLASSIFICATION: UNCLASSIFIED [x] CONFIDENTIAL [ ] SECRET [ ]

Page 2 of 7

Date 16 September 1963

SUPERSEDES Date

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3. SPECIFICATION NO.
NA-MA5-99	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S
4. CONTRACT	**5. CONTRACTUAL AUTHORIZATION**	**FILE OPPOSITE SPEC. PAGE NO.** 6
AF04(694)-58	CCN 56 (N58-639)	Other pages affected: 1, 7,11,14,55,68,69 and 71

6. PRODUCTION EFFECTIVITY:

NA336511 and subsequent

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

Paragraph 3.3.3 Estimates

1. Change "Fuel pressure 529 psia" to read "Fuel pressure 448 psia."

2. Change "LOX pressure 504 psia" to read "LOX pressure 509 psia."

Form 608-B-8

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.

SPECIFICATION CHANGE NOTICE

Number 2

SECURITY CLASSIFICATION: UNCLASSIFIED [X] CONFIDENTIAL [ ] SECRET [ ]

Page 3 of 7

Date 16 September 1963

SUPERSEDES Date

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3. SPECIFICATION NO.
NA-MA5-99	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S
4. CONTRACT	**5. CONTRACTUAL AUTHORIZATION**	**FILE OPPOSITE SPEC. PAGE NO. 7**
AF04(694)-58	CCN 56 (N58-639)	Other pages affected: 1, 6,11,14,55,68,69 and 71

6. PRODUCTION EFFECTIVITY:

NA336511 and subsequent

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

Table I YLR101-NA-15 Rating at standard sea-level static conditions

Change Table I to read as follows:

	Engine thrust lbs (a)	Engine instantaneous specific impulse, seconds, min. (b)	Engine altitude (0 psia ambient) specific impulse, seconds, calculated min. (b)	Engine altitude (0 psia ambient) thrust pounds, calculated minimum	Nominal chamber pressure, psia	Engine mixture ratio O/F	Engine inlet pressures, psia	
							Fuel	Oxidizer
(c) Tank-fed	525	171	221	698	207	1.80	335	390
Pump-fed	699 Max 639 Min	180	226	811	250	1.72±4%	448	509

(a) Engine thrust considered parallel to thrust chamber axis. The engine thrust values are corrected to rated engine inlet conditions.

(b) The average pump-fed specific impulse of an individual engine, corrected to rated thrust, mixture ratio, and engine inlet conditions, shall be equal to or greater than the minimum specified.

(c) The tank-fed ratings are estimated and are for reference only.

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.

SPECIFICATION CHANGE NOTICE

Number 2

SECURITY CLASSIFICATION: UNCLASSIFIED [X] CONFIDENTIAL [ ] SECRET [ ]

Page 4 of 7

Date 16 September 1963

SUPERSEDES Date

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3. SPECIFICATION NO.
NA MA5-99	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S
4. CONTRACT	**5. CONTRACTUAL AUTHORIZATION**	**FILE OPPOSITE SPEC. PAGE NO. 11**
AF04(694)-58	CCN 56 (N58-639)	Other pages affected: 1, 6,7,14,55,68,69 and 71

6. PRODUCTION EFFECTIVITY:

NA336511 and subsequent.

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

Paragraph 3.3.10.1.1 Mixture ratio

Change the paragraph to read:

The mixture ratio shall be controlled within safe operating limits during mainstage operation and during thrust increase and decrease. The safe operating mixture ratio limits are specified as 1.6 to 1.95.

(1) Pump-fed operation: The YLR101-NA-15 mixture ratio is dependent upon the YLR105-NA-7 rated performance.

(2) Tank-fed operation: Nominal mixture ratio shall be as specified in Table I.

Paragraph 3.3.10.2 Thrust

Change the paragraph to read:

There are no intermediate controlled-thrust settings.

(1) Pump-fed operation: The thrust limits specified in Table I are dependent upon the YLR105-NA-7 rated performance.

(2) Tank-fed operation: Nominal thrust shall be as specified in Table I.

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.

SPECIFICATION CHANGE NOTICE

Number 2

SECURITY CLASSIFICATION: UNCLASSIFIED [X] CONFIDENTIAL [ ] SECRET [ ]

Page 5 of 7

Date 16 September 1963

SUPERSEDES Date

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3. SPECIFICATION NO.
NA-MA5-99	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S
4. CONTRACT	**5. CONTRACTUAL AUTHORIZATION**	**FILE OPPOSITE SPEC. PAGE NO. 14**
AF04(694)-58	CCN 56 (N58-639)	Other pages affected: 1, 6,7,11,55,68,69 and 71

6. PRODUCTION EFFECTIVITY:

NA336511 and subsequent.

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

Paragraph 3.5 Drawing and data

Change YLR101-NA-15 MD Number Identification to incorporate MD2

Form 608-B-8

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.

SPECIFICATION CHANGE NOTICE

Number 2

SECURITY CLASSIFICATION: UNCLASSIFIED [X] CONFIDENTIAL [ ] SECRET [ ]

Page 6 of 7

Date 16 September 1963

SUPERSEDES Date

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3. SPECIFICATION NO.
NA-MA5-99	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S
4. CONTRACT	**5. CONTRACTUAL AUTHORIZATION**	**FILE OPPOSITE SPEC. PAGE NO.** 55
AF04(694)-58	CCN 56 (N58-639)	Other pages affected: 1, 6,7,11,14,68,69 and 71

6. PRODUCTION EFFECTIVITY:

NA-336511 and subsequent.

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

Paragraph 4.2.4 (5152)

Change "tank-fed" to read "pump-fed" in lines two and eight.

Change last sentence to read "The tank-fed ratings, except cutoff impulse shall not be demonstrated or reported."

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.

SPECIFICATION CHANGE NOTICE

Number 2

SECURITY CLASSIFICATION: UNCLASSIFIED [X] CONFIDENTIAL [ ] SECRET [ ]

Page 7 of 7

Date 16 September 1963

SUPERSEDES Date

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3. SPECIFICATION NO.
NA-MA5-99	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S
4. CONTRACT	**5. CONTRACTUAL AUTHORIZATION**	**FILE OPPOSITE SPEC. PAGE NO.** 68 & as noted. Other pages affected 1, 6,7,11,14,55,69 and 71
AF04(694)-58	CCN 56 (N58-639)	

6. PRODUCTION EFFECTIVITY:

NA336511 and subsequent

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

As noted

Replace Figure 1, 2 and 4 with Figures 1, 2, and 4 revised* to reflect incorporation of MD2, made a part hereof as Attachments I through III

* NOTE: The revised figures attached are as follows:

Page	Figure	Attachment
68	1	I
69	2	II
71	4	III

Form 608-B-8

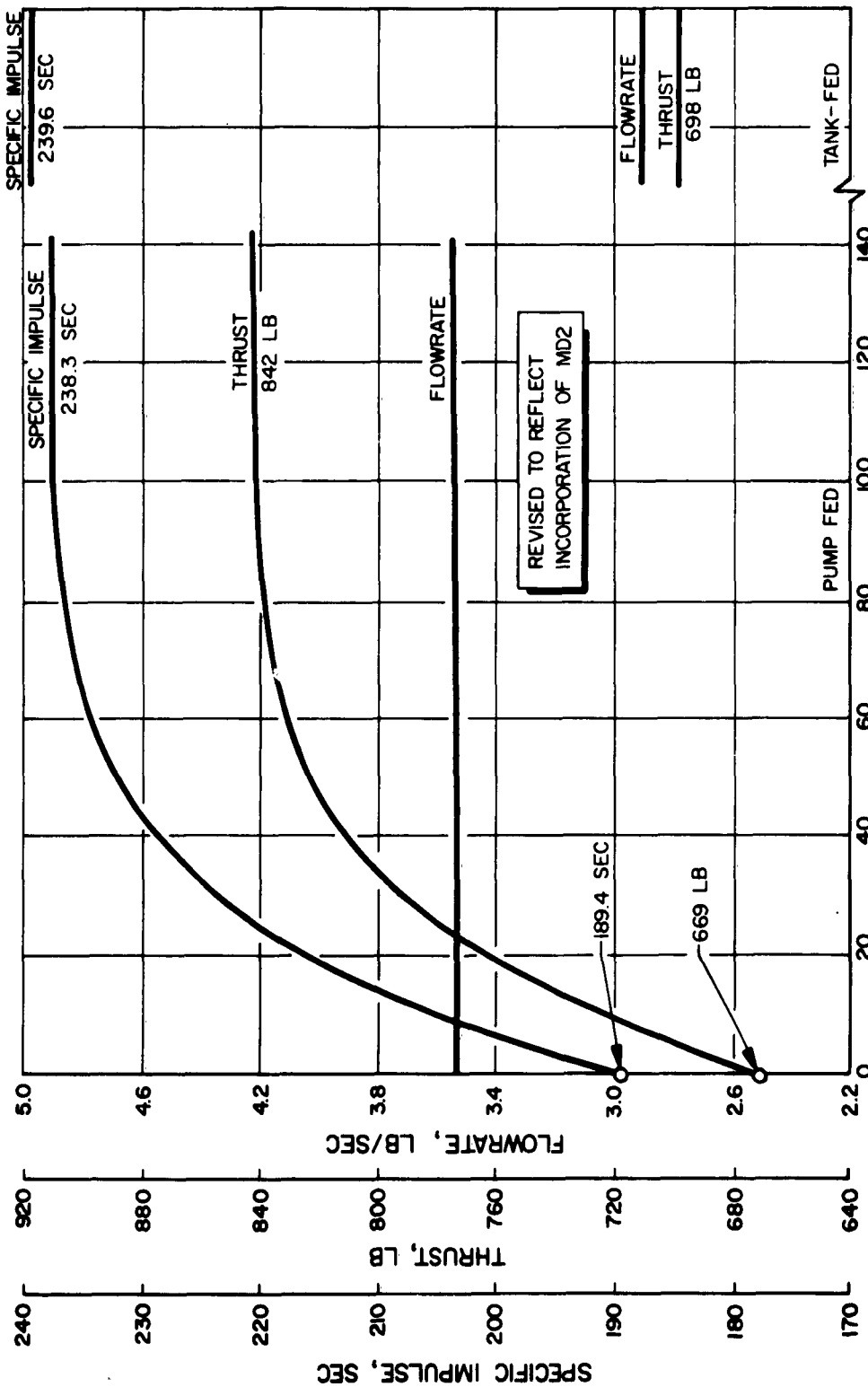


FIGURE 1
ESTIMATED NOMINAL ALTITUDE PERFORMANCE
YLR-101-NA-15 MD 2

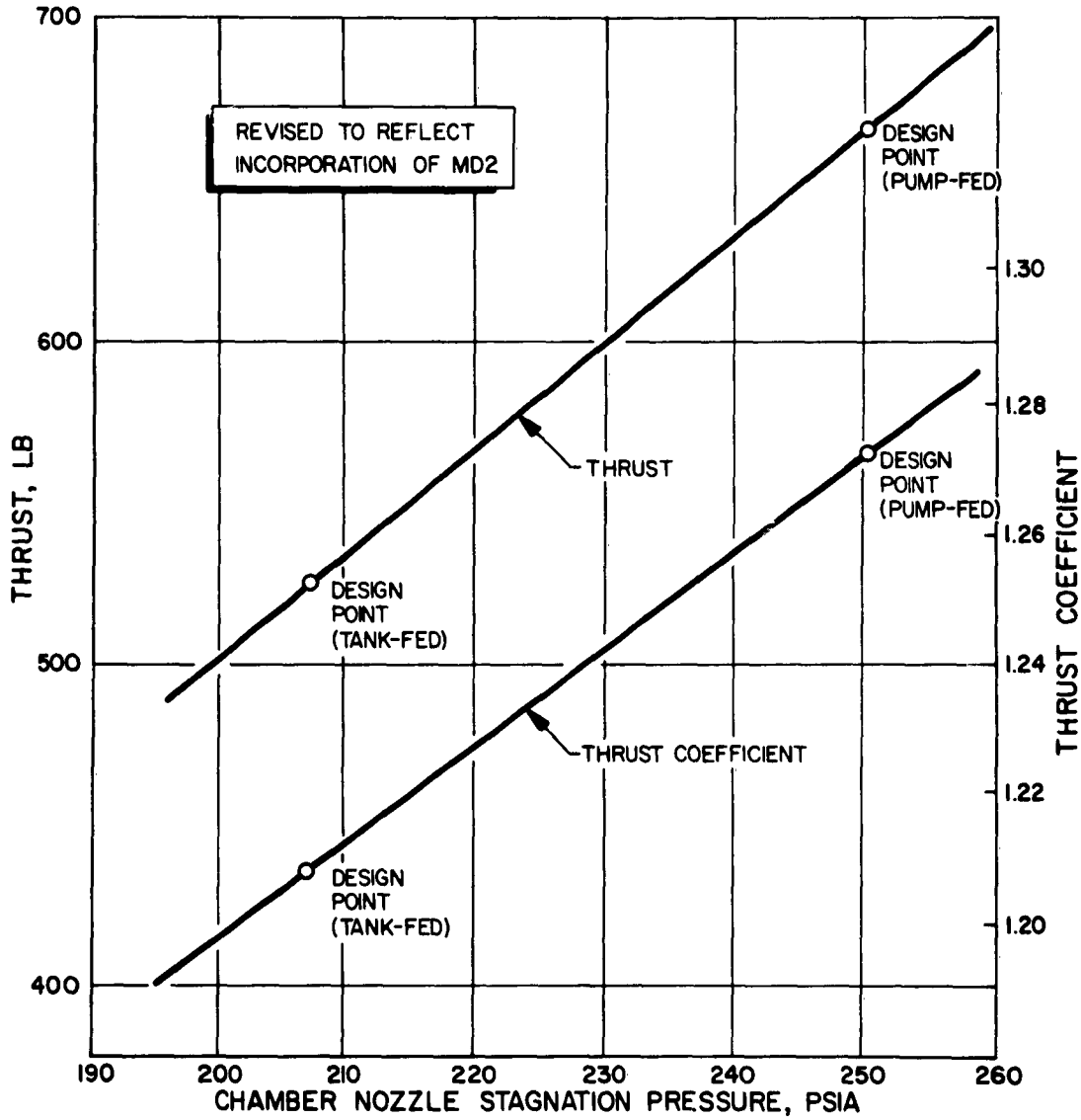


FIGURE 2

ESTIMATED SEA-LEVEL THRUST AND THRUST COEFFICIENT
VERSUS
CHAMBER NOZZLE STAGNATION PRESSURE

YLR 101-NA-15 THRUST CHAMBER
(NOZZLE EXPANSION AREA RATIO 5.6:1)

As of 21 October 1963

SPECIFICATION CHANGE INDEX

Specification No. R-3953S

SCN No.	MA5-ECP No.	SCN Date	Pages Affected	Item Affected YLR101-NA-15 MD Ident No.	Subject
1	92	18 Jun 1963	1, 6, 7, 12, 14, 68, 69 70, 71	1	Provisions for YLR101-NA 15 Vernier Engine Thrust-level Increase.
2	99	16 Sep 1963	1, 6, 7, 11 14, 55, 68, 69, 70, 71	2	Replacement of YLR101-NA-15 Vernier Engine Thrust Chamber Injector Assembly.

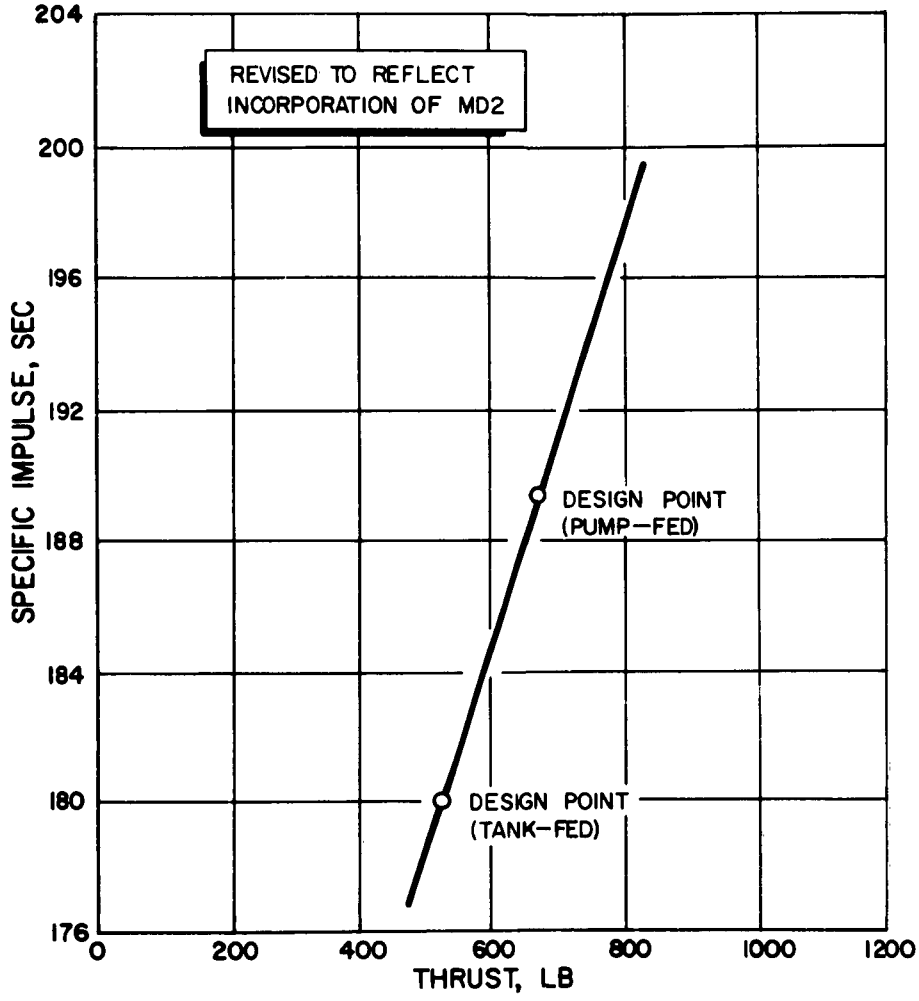


FIGURE 4

ESTIMATED SEA LEVEL SPECIFIC IMPULSE
VERSUS
THRUST

YLR 101-NA-15 THRUST CHAMBER

FOR ERRATA

AD _____

409534

THE FOLLOWING PAGES ARE CHANGES

TO BASIC DOCUMENT

As of 3 July 1963

SPECIFICATION CHANGE INDEX

Specification No. R-3953S

SCN No.	MA5 ECP No.	SCN Date	Pages Affected	Item Affected YLR101-NA-15 MD Ident. No.
1	92	18 June 1963	1, 6, 7, 12, 14, 68, 69, 70, 71	1

Following is the subject of the above change:

SCN No.

Thrust-level Increase, YLR101-NA-15 Vernier Engine; Provisions for

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.

SPECIFICATION CHANGE NOTICE

Number 1

SECURITY CLASSIFICATION: UNCLASSIFIED [X] CONFIDENTIAL [ ] SECRET [ ]

Page 1 of 6

Date 18 June 1963

SUPERSEDES Date

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3. SPECIFICATION NO.
NA-MA5-92	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S
4. CONTRACT	**5. CONTRACTUAL AUTHORIZATION**	**FILE OPPOSITE SPEC. PAGE NO. 1**
AF04(694)-58	CCN50(N58-64MSN26)	Other pages affected: 6,7,12,14,68,69,70,71

6. PRODUCTION EFFECTIVITY:

NA336501 through NA336510 only.

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

Paragraph 1.2 Classification

Change "525 pounds" to read "777 pounds."

Form 608-B-8
sec

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.

SPECIFICATION CHANGE NOTICE

Number 1

SECURITY CLASSIFICATION: UNCLASSIFIED [X] CONFIDENTIAL [ ] SECRET [ ]

Date 18 June 1963

SUPERSEDES Date

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3. SPECIFICATION NO.
NA-MA5-92	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S
4. CONTRACT	**5. CONTRACTUAL AUTHORIZATION**	**FILE OPPOSITE SPEC. PAGE NO.** 6
AF04(694)-58	CCN50(N58-64MSN26)	Other pages affected: 1,7,12,14,68,69,70,71

6. PRODUCTION EFFECTIVITY:

NA336501 through NA336510 only.

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

Paragraph 3.3.3 Estimates

1. Change "Fuel pressure 529 psia" to read "Fuel pressure 678 psia."

2. Change "LOX pressure 504 psia" to read "LOX pressure 646 psia."

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.

SPECIFICATION CHANGE NOTICE

Number 1

SECURITY CLASSIFICATION: UNCLASSIFIED [X] CONFIDENTIAL [ ] SECRET [ ]

Date 18 June 1963

SUPERSEDES Date

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3. SPECIFICATION NO.
NA-MA5-92	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S
4. CONTRACT	**5. CONTRACTUAL AUTHORIZATION**	**FILE OPPOSITE SPEC. PAGE NO. 7**
AF04(694)-58	CCN50(N58-64MSN26)	Other pages affected: 1,6,12,14,68,69,70,71

6. PRODUCTION EFFECTIVITY:

NA336501 through NA336510 only.

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

Table I YLR101-NA-15 Rating at standard sea-level static conditions

Change Table I to read as follows:

	Engine thrust lbs. (a)	Engine instantaneous specific impulse, seconds, min. (b)	Engine altitude (0 psia ambient) specific impulse, seconds, calculated min. (b)	Engine altitude (0 psia ambient) thrust pounds, calculated minimum	Nominal chamber pressure, psia	Engine mixture ratio O/F	Engine inlet pressures, psia	
							Fuel	Oxidizer
YLR101-NA-15 Tank-fed	802 Max. 777 752 Min.	187	228	925	282	1.80±4%	543	543
(c) Pump-fed	909	192	241	1081	322	1.72	678	646

(a) Engine thrust considered parallel to thrust chamber axis. The engine thrust values are corrected to rated engine inlet conditions.

(b) The average specific impulse of an individual engine, corrected to rated thrust, mixture ratio, and engine inlet conditions, shall be equal to or greater than the minimum specified.

(c) The pump-fed ratings are estimated at nominal conditions and are for reference only.

Form 608-8-8

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.

SPECIFICATION CHANGE NOTICE

Number 1

SECURITY CLASSIFICATION: UNCLASSIFIED [X] CONFIDENTIAL [ ] SECRET [ ]

Date 18 June 1963

SUPERSEDES Date

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3. SPECIFICATION NO.
NA-MA5-92	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S
4. CONTRACT	**5. CONTRACTUAL AUTHORIZATION**	**FILE OPPOSITE SPEC. PAGE NO. 12**
AF04(694)-58	CCN50(N58-64MSN26)	Other pages affected: 1,6,7,14,68,69,70,71

6. PRODUCTION EFFECTIVITY:

NA336501 through NA336510 only

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

Paragraph 3.3.10.2.3 Decrease

Change the tabulated information to read as follows:

Delay circuit inactive	Delay circuit active
min. 82 lb-sec	min. 111 lb-sec
max. 132 lb-sec	max. 189 lb-sec

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.

SPECIFICATION CHANGE NOTICE

Number 1

SECURITY CLASSIFICATION: UNCLASSIFIED [X] CONFIDENTIAL [ ] SECRET [ ]

Page 5 of 6

Date 18 June 1963

SUPERSEDES Date

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3. SPECIFICATION NO.
NA-MA5-92	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S
4. CONTRACT	**5. CONTRACTUAL AUTHORIZATION**	**FILE OPPOSITE SPEC. PAGE NO. 14**
AF04(694)-58	CCN50(N58-64MSN26)	Other pages affected: 1,6,7,12,68,69,70,71

6. PRODUCTION EFFECTIVITY:

NA336501 through NA336510 only.

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

Paragraph 3.5 Drawings and data

Change YLR101-NA-15 MD Number Identification to incorporate MD1.

Form 608-B-8

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.

SPECIFICATION CHANGE NOTICE

Number 1

SECURITY CLASSIFICATION: UNCLASSIFIED [X] CONFIDENTIAL [ ] SECRET [ ]

Page 6 of 6

Date 18 June 1963

SUPERSEDES Date

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3. SPECIFICATION NO.
NA-MA5-92	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S
4. CONTRACT	**5. CONTRACTUAL AUTHORIZATION**	**FILE OPPOSITE SPEC. PAGE NO.** 68 & as noted. Other pages affected: 1,6,7,12,14,69,70,71
AF04(694)-58	CCN50(N58-64MSN26)	

6. PRODUCTION EFFECTIVITY:

NA336501 through NA336510 only.

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

As noted

Replace Figures 1 through 4 with Figures 1 through 4 revised* to reflect incorporation of MD1, made a part hereof as Attachments I through IV.

*NOTE: The revised figures attached are as follows:

Page 68	Figure 1	Attachment I
69	2	II
70	3	III
71	4	IV

Form 608-B-8

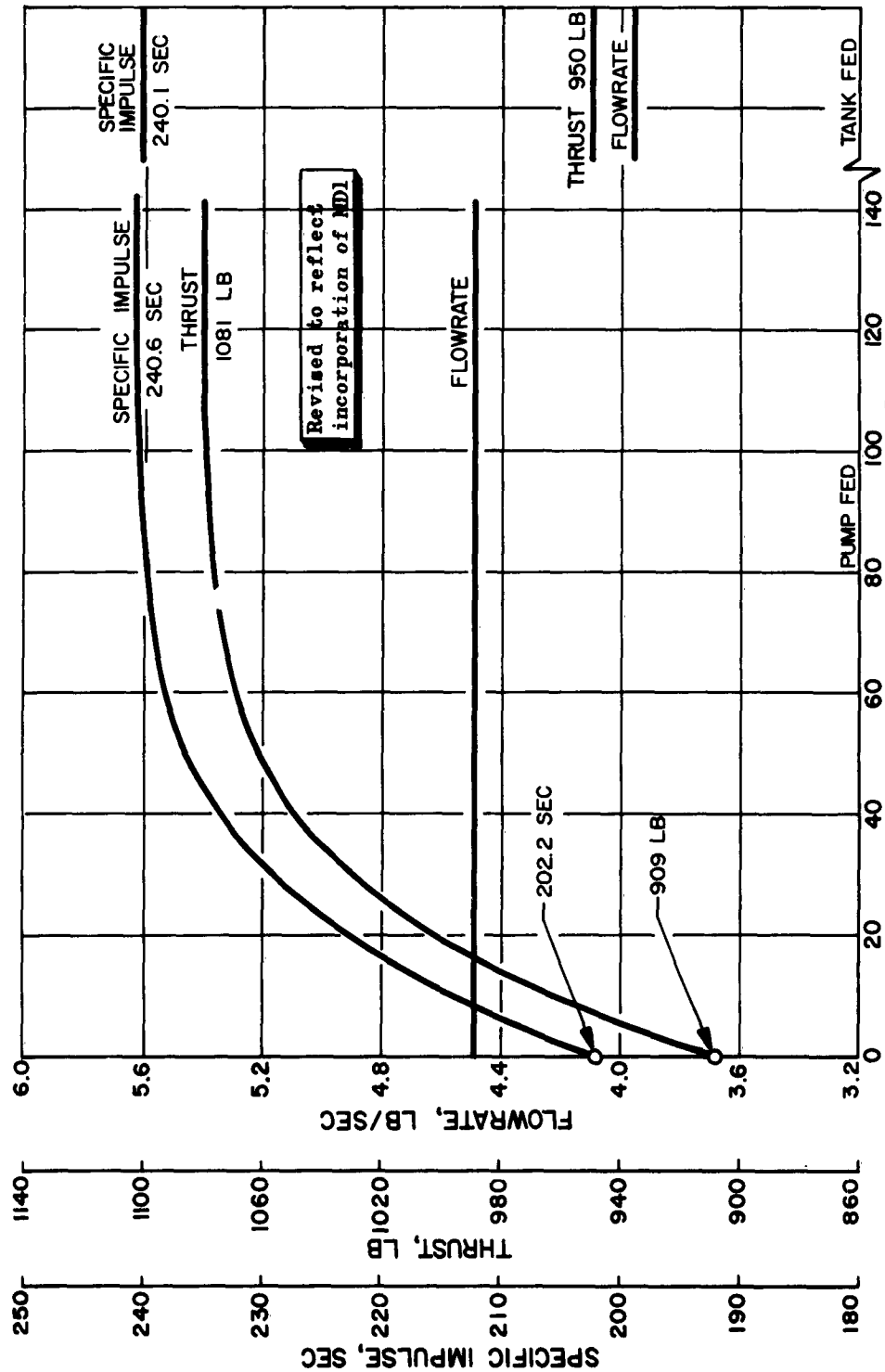


FIGURE 1
ESTIMATED NOMINAL ALTITUDE PERFORMANCE
YLR-101-NA-15 MD1

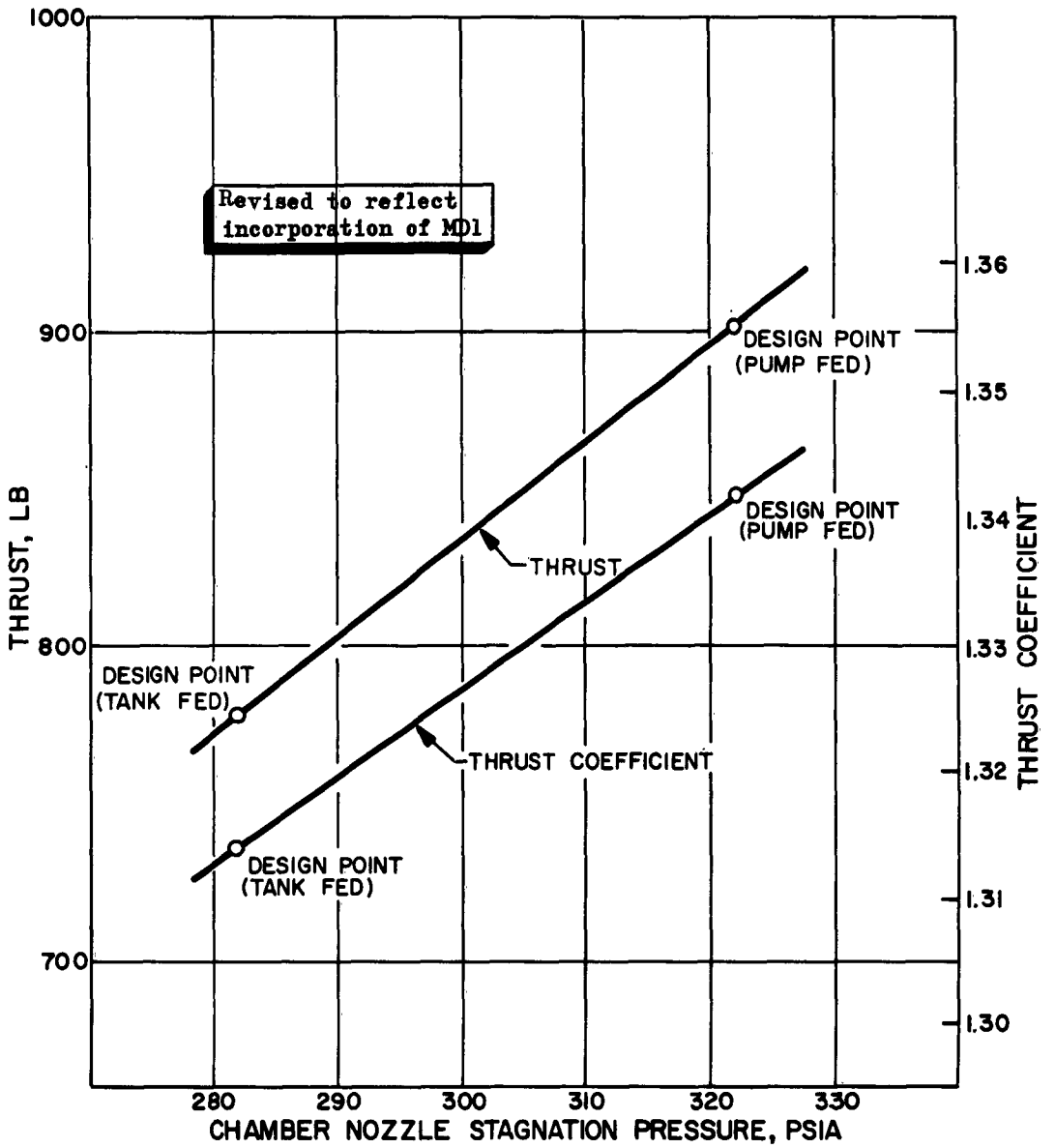


FIGURE 2

ESTIMATED SEA-LEVEL THRUST AND THRUST COEFFICIENT
VERSUS
CHAMBER NOZZLE STAGNATION PRESSURE

YLR 101-NA-15 MD1 THRUST CHAMBER

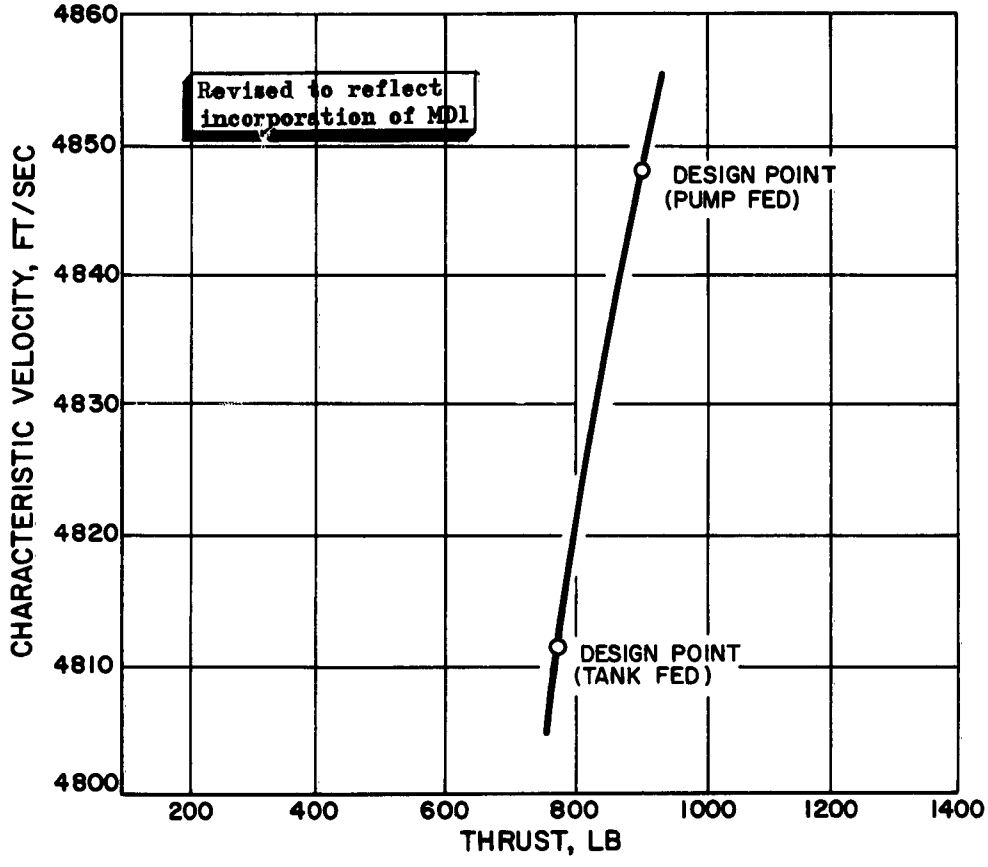


FIGURE 3

ESTIMATED CHARACTERISTIC VELOCITY
VERSUS
SEA LEVEL THRUST

YLR 101-NA-15 MD1 THRUST CHAMBER

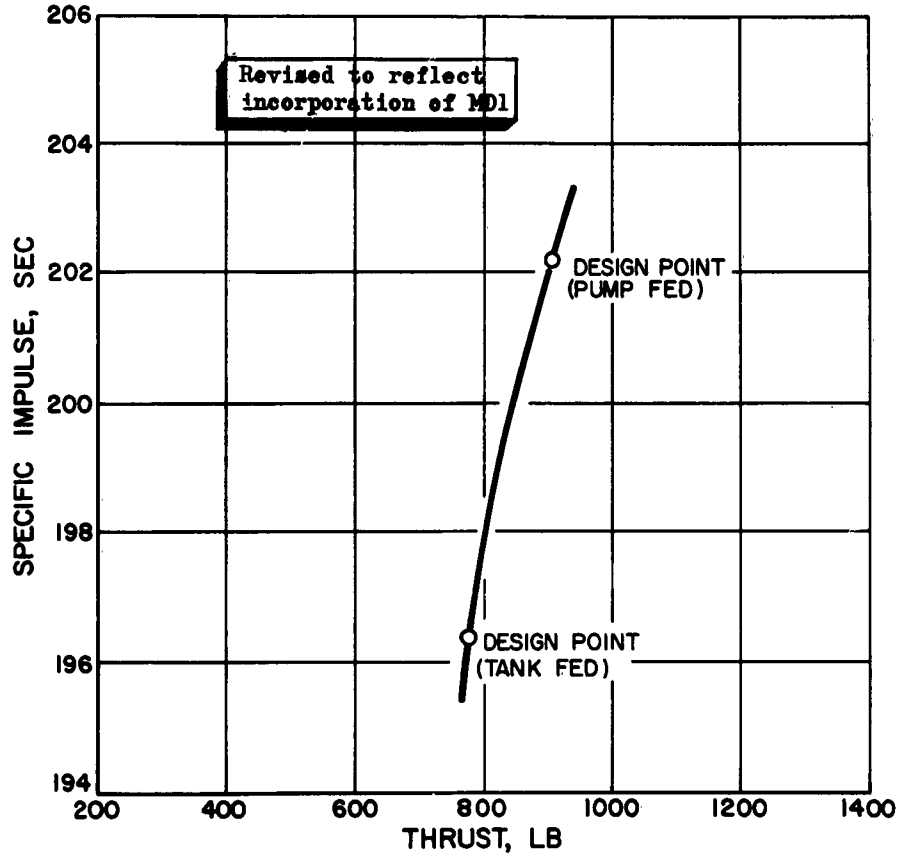


FIGURE 4

ESTIMATED SEA LEVEL SPECIFIC IMPULSE
VS
THRUST

YLR 101-NA-15 MD1 THRUST CHAMBER

FOR ERRATA

AD 409534

THE FOLLOWING PAGES ARE CHANGES

TO BASIC DOCUMENT

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.

SPECIFICATION CHANGE NOTICE

Number 2

SECURITY CLASSIFICATION: UNCLASSIFIED [X] CONFIDENTIAL [ ] SECRET [ ]

Page 7 of 7

Date 17 September 1964

SUPERSEDES Date 25 March 1964

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3. SPECIFICATION NO.
NA-MA5-99R1	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S
4. CONTRACT	**5. CONTRACTUAL AUTHORIZATION**	**FILE OPPOSITE SPEC. PAGE NO.** 68 & as noted.
AF04(694)-58	CCN 7(N58-SSD65MSN-576)	Other pages affected: 1,6,7,11,14,55,69 & 71

6. PRODUCTION EFFECTIVITY:

NA336511 through NA336576, and NA336581 and subsequent.

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

As noted

Page 68	Figure 1	Attachment I
69	2	II
71	4	III

NOTE: Figures 1, 2, and 4 which were issued as Attachments I through III to SCN2 dated 16 September 1963 are to be retained for use with SCN2 (revised) dated 17 September 1964.

Form 606-B-8

17 September 1964

SPECIFICATION CHANGE INDEX

Specification No. R-39538

	SCN No.	MA5 ECP No.	SCN Date	Pages Affected	Item Affected YLR101-NA-15 MD Ident. No.	Subject
ø	1	92R1	17 Sept. 1964	1,6,7, 12,14,68, 69,70,71	1	Provisions for YLR101-NA-15 Vernier Engine Thrust-level Increase.
ø	2	99R1	17 Sept. 1964	1,6,7,11, 14,55,68, 69,70,71	2	Replacement of YLR101-NA-15 Vernier Engine Thrust Chamber Injector Assembly.
	3	102R1	10 June 1964	14	3	Addition of YLR101-NA-15 Vernier Engine Torque Striping.

ø Denotes changes to the Specification Change Index.

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.

SPECIFICATION CHANGE NOTICE

Number 1

SECURITY CLASSIFICATION: UNCLASSIFIED [X] CONFIDENTIAL [ ] SECRET [ ]

Page 1 of 6

Date 17 September 1964

SUPERSEDES Date 25 March 1964

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3. SPECIFICATION NO.
NA-MA5-92R1	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S
4. CONTRACT	**5. CONTRACTUAL AUTHORIZATION**	**FILE OPPOSITE SPEC. PAGE NO. 1**
AF04(694)-58	CCN50(N58-64MSN-26) CCN68(N58-SSD65MSN-577)	Other pages affected: 5,6,11,14,68,69,70,71

6. PRODUCTION EFFECTIVITY:

NA336501 through NA336510 and NA336577 through NA336580 only.

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

Paragraph 1.2 Classification

Change "525 pounds" to read "777 pounds."

NOTE: Attachments I through IV issued with SCN 1 dated 18 June 1963 are to be retained for use with SCN1 dated 17 September 1964.

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.

SPECIFICATION CHANGE NOTICE

Number 1

SECURITY CLASSIFICATION: UNCLASSIFIED [X] CONFIDENTIAL [ ] SECRET [ ]

Date 17 September 1964

SUPERSEDES Date 25 March 1964

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3. SPECIFICATION NO.
NA-MA5-92R1	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S
4. CONTRACT	**5. CONTRACTUAL AUTHORIZATION**	**FILE OPPOSITE SPEC. PAGE NO.** 5
AF04(694)-58	CCN50(N58-64MSN-26) CCN68(N58-SSD65MSN-577)	Other pages affected: 1,6,11,14,68,69,70 & 71

6. PRODUCTION EFFECTIVITY:

NA336501 through NA336510 and NA336577 through NA336580 only.

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

Paragraph 3.3.3 Estimates

1. Change "Fuel pressure 529 psia" to read "Fuel pressure 678 psia."

2. Change "LOX pressure 504 psia" to read "LOX pressure 646 psia."

1

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ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.

SPECIFICATION CHANGE NOTICE

Number 1

SECURITY CLASSIFICATION: UNCLASSIFIED [X] CONFIDENTIAL [ ] SECRET [ ]

Date 17 September 1964

SUPERSEDES Date 25 March 1964

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3. SPECIFICATION NO.
NA-MA5-92R1	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S
4. CONTRACT	**5. CONTRACTUAL AUTHORIZATION**	**FILE OPPOSITE SPEC. PAGE NO. 6**
AF04(694)-58	CCN50(N58-64MSN-26) CCN68(N58-SSD65MSN-577)	Other pages affected: 1,5,11,14,68,69,70 & 71

6. PRODUCTION EFFECTIVITY:

NA336501 through NA336510 and NA336577 through NA336580 only.

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

Table I YLR101-NA-15 Rating at standard sea level static conditions

Change Table I to read as follows:

Engine	Engine Thrust lbs.	Engine instantaneous specific impulse seconds, min.	Engine altitude (0 psia ambient) specific impulse, seconds, calculated min. (b)	Engine altitude (0 psia ambient) thrust pounds calculated minimum	Nominal chamber pressure psia	Engine mixture ratio O/F	Engine inlet pressures, psia	
							Fuel	Oxidize
YLR101-NA-15 Tank-fed	802 max. 777 752 min.	187	228	925	282	1.80±4%	543	543
(c) Pump-Fed	909	192	241	1081	322	1.72	678	646

(a) Engine thrust considered parallel to thrust chamber axis. The engine thrust values are corrected to rated engine inlet conditions.

(b) The average specific impulse of an individual engine, corrected to rated thrust, mixture ratio, and engine inlet conditions, shall be equal to or greater than the minimum specified.

(c) The pump-fed ratings are estimated at nominal conditions and are for reference only.

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.

SPECIFICATION CHANGE NOTICE

Number 1

SECURITY CLASSIFICATION: UNCLASSIFIED [X] CONFIDENTIAL [ ] SECRET [ ]

Page 4 of 6

Date 17 September 1964

SUPERSEDES Date 25 March 1964

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3. SPECIFICATION NO.
NA-MA5-92R1	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S
4. CONTRACT	**5. CONTRACTUAL AUTHORIZATION**	**FILE OPPOSITE SPEC. PAGE NO. 11**
AF04(694)-58	CCN50(N58-64MSN-26) CCN68(N58-SSD65MSN-577)	Other pages affected: 1,5,6,11,14,68,69,70, & 71

6. PRODUCTION EFFECTIVITY:

NA336501 through NA336510 and NA336577 through NA336580 only.

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

Paragraph 3.3.10.2.3 Decrease

Change the tabulated information to read as follows:

Delay circuit inactive	Delay circuit active
min. 182 lb-sec	min. 111 lb-sec
max. 132 lb-sec	max. 189 lb-sec

Form 608-8-8

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.

SPECIFICATION CHANGE NOTICE

Number 1

SECURITY CLASSIFICATION: UNCLASSIFIED [X] CONFIDENTIAL [ ] SECRET [ ]

Page 5 of 6

Date 17 September 1964

SUPERSEDES Date 25 March 1964

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3. SPECIFICATION NO.
NA-MA5-92R1	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S
4. CONTRACT	**5. CONTRACTUAL AUTHORIZATION**	**FILE OPPOSITE SPEC. PAGE NO. 14**
AF04(694)-58	CCN50(N58-64MSN-26) CCN68(N58-SSD65MSN-577)	Other pages affected: 1,5,6,11,68,69,70 & 71

6. PRODUCTION EFFECTIVITY:

NA336501 through NA336510 and NA336577 through NA336584 only

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

Paragraph 3.5 Drawings and data

Change YLR101-NA-15 MD Number Identification to incorporate MD1.

Form 608-B-8

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.

SPECIFICATION CHANGE NOTICE

Number 1

SECURITY CLASSIFICATION: UNCLASSIFIED [X] CONFIDENTIAL [ ] SECRET [ ]

Page 6 of 6

Date 17 September 1964

SUPERSEDES Date 25 March 1964

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3. SPECIFICATION NO.
NA-MA5-92R1	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S
4. CONTRACT	**5. CONTRACTUAL AUTHORIZATION**	**FILE OPPOSITE SPEC. PAGE NO. 68 and as noted:**
AF04(694)-58	CCN50(N58-64MSN-26) CCN68(N58-SSD65MSN-577)	Other pages affected: 1,5,6,11,14,69,70 & 71

6. PRODUCTION EFFECTIVITY:

NA336501 through NA336510 and NA336577 through NA336580 only.

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

As Noted

Page 68	Figure 1	Attachment I
69	2	II
70	3	III
71	4	IV

NOTE: Figures 1 through 4 which were issued as Attachments I through IV to SCN1 dated 18 June 1963 are to be retained for use with SCN1 (revised) dated 17 September 1964.

Form 608-B-8

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.

SPECIFICATION CHANGE NOTICE

Number 2

SECURITY CLASSIFICATION: UNCLASSIFIED [X] CONFIDENTIAL [ ] SECRET [ ]

Page 1 of 7

Date 17 September 1964

SUPERSEDES Date 25 March 1964

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3. SPECIFICATION NO.
NA-MA5-99R1	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S
4. CONTRACT	**5. CONTRACTUAL AUTHORIZATION**	**FILE OPPOSITE SPEC. PAGE NO. 1**
AF04(694)-58	CCN67(N58-SSD65MSN-576)	Other pages affected: 6,7,11,14,55,68,69 & 71

6. PRODUCTION EFFECTIVITY:

NA336511 through NA336576, and NA336581 and subsequent.

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

Paragraph 1.2 Classification

Change the first sentence to read:

The rocket engine is a calibrated, fixed-thrust bipropellant rocket engine with a nominal sea-level pump-fed rating of 669 pounds.

NOTE: Attachments I through III issued with SCN2 dated 16 September 1963 are to be retained for use with SCN2 dated 17 September 1964.

Form 608-8-8

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.

SPECIFICATION CHANGE NOTICE

Number 2

SECURITY CLASSIFICATION: UNCLASSIFIED [X] CONFIDENTIAL [ ] SECRET [ ]

Page 2 of 7

Date 17 September 1964

SUPERSEDES Date 25 March 1964

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3. SPECIFICATION NO.
NA-MA5-99R1	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S
4. CONTRACT	**5. CONTRACTUAL AUTHORIZATION**	**FILE OPPOSITE SPEC. PAGE NO.** 6
AF04(694)-58	CCN67(N58-SSD65MSN-576)	Other pages affected: 1,7,11,14,55,68,69 & 71

6. PRODUCTION EFFECTIVITY:

NA336511 through NA336576, and NA336581 and subsequent.

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

Paragraph 3.3.3 Estimates

1. Change "Fuel pressure 529 psia" to read "Fuel pressure 448 psia."

2. Change "LOX pressure 504 psia" to read "LOX pressure 509 psia."

Form 608-B-8

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.

SPECIFICATION CHANGE NOTICE

Number 2

SECURITY CLASSIFICATION: UNCLASSIFIED [X] CONFIDENTIAL [ ] SECRET [ ]

Date 17 September 1964

SUPERSEDES Date 25 March 1964

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3. SPECIFICATION NO.
NA-MA5-99R1	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S
4. CONTRACT	**5. CONTRACTUAL AUTHORIZATION**	**FILE OPPOSITE SPEC. PAGE NO.** 7
AF04(694)-58	CCN67(N58-SSD65MSN-576)	Other pages affected: 1,6,11,14,55,68,69 & 71

6. PRODUCTION EFFECTIVITY:

NA336511 through NA336576, and NA336581 and subsequent

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

Table I YLR101-NA-15 Rating at standard sea-level static conditions

Change Table I to read as follows:

Engine Thrust lbs (a)	Engine instantaneous specific impulse, seconds, min. (b)	Engine altitude (0 psia ambient) specific impulse, seconds, calculated min. (b)	Engine altitude (0 psia ambient) thrust pounds, calculated minimum	Nominal chamber pressure, psia	Engine mixture ratio O/F	Engine inlet pressures, psia	
						Fuel	Oxidizer
(c) Tank-Fed 525	171	221	698	207	1 80	335	390
699 Max Pump-Fed 639 Min	180	226	811	250	1.72±4%	448	509

(a) Engine thrust considered parallel to thrust chamber axis. The engine thrust values are corrected to rated engine inlet conditions.

(b) The average pump-fed specific impulse of an individual engine, corrected to rated thrust, mixture ratio, and engine inlet conditions, shall be equal to or greater than the minimum specified.

(c) The tank-fed ratings are estimated and are for reference only.

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.

SPECIFICATION CHANGE NOTICE

Number 2

SECURITY CLASSIFICATION: UNCLASSIFIED [X] CONFIDENTIAL [ ] SECRET [ ]

Date 17 September 1964

SUPERSEDES Date 25 March 1964

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3. SPECIFICATION NO.
NA-MA5-99R1	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S
4. CONTRACT	**5. CONTRACTUAL AUTHORIZATION**	**FILE OPPOSITE SPEC. PAGE NO.** 11
AF04(694)-58	CCN67(N58-SSD65MSN-576)	Other pages affected: 1,6,7,14,55,68,69, & 71

6. PRODUCTION EFFECTIVITY:

NA336511 through NA336576, and NA336581 and subsequent.

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

Paragraph 3.3.10.1.1 Mixture ratio

Change the paragraph to read:

The mixture ratio shall be controlled within safe operating limits during mainstage operation and during thrust increase and decrease. The safe operating mixture ratio limits are specified as 1.6 to 1.95.

(1) Pump-fed operation: The YLR101-NA-15 mixture ratio is dependent upon the YLR105-NA-7 rated performance.

(2) Tank-fed operation: Nominal mixture ratio shall be as specified in Table I.

Paragraph 3.3.10.2 Thrust

Change the paragraph to read:

There are no intermediate controlled-thrust settings.

(1) Pump-fed operation: The thrust limits specified in Table I are dependent upon the YLR105-NA-7 rated performance.

(2) Tank-fed operation: Nominal thrust shall be as specified in Table I.

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A DIVISION OF NORTH AMERICAN AVIATION, INC.

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Date 17 September 1964

SUPERSEDES Date 25 March 1964

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3. SPECIFICATION NO.
NA-MA5-99R1	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S
4. CONTRACT	**5. CONTRACTUAL AUTHORIZATION**	**FILE OPPOSITE SPEC. PAGE NO. 14**
AF04(694)-58	CCN67(N58-SSD65MSN-576)	Other pages affected: 1,6,7,11,55,68,69 & 71

6. PRODUCTION EFFECTIVITY:

NA336511 through NA336576, and NA336581 and subsequent.

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

Paragraph 3.5 Drawing and data

Change YLR101-NA-15 MD Number Identification to incorporate MD2.

Form 608-B-8

ROCKETDYNE
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Date 17 September 1964

SUPERSEDES Date 25 March 1964

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3. SPECIFICATION NO.
NA-MA5-99R1	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S
4. CONTRACT	**5. CONTRACTUAL AUTHORIZATION**	**FILE OPPOSITE SPEC. PAGE NO. 55**
AF04(694)-58	CCN67(N58-SSD65MSN-576)	Other pages affected: 1,6,7,11,14,68,69 & 71

6. PRODUCTION EFFECTIVITY:

NA336511 through NA336576, and NA336581 and subsequent.

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

Paragraph 4.2.4 (5152)

Change "tank-fed" to read "pump-fed" in lines two and eight.

Change last sentence to read "The tank-fed ratings, except cutoff impulse shall not be demonstrated or reported."

Form 608-B-8

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.

SPECIFICATION CHANGE NOTICE

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SECURITY CLASSIFICATION: UNCLASSIFIED [X] CONFIDENTIAL [ ] SECRET [ ]

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Date 17 September 1964

SUPERSEDES Date 25 March 1964

1. FOR ECP NO.	2. NOMENCLATURE AND MODEL	3. SPECIFICATION NO.
NA-MA5-99R1	Liquid Propellant Rocket Engine Model YLR101-NA-15 (Vernier)	R-3953S
4. CONTRACT	**5. CONTRACTUAL AUTHORIZATION**	**FILE OPPOSITE SPEC. PAGE NO.** 68 & as noted.
AF04(694)-58	CCN67(N58-SSD65MSN-576)	Other pages affected: 1,6,7,11,14,55,69 & 71

6. PRODUCTION EFFECTIVITY:

NA336511 through NA336576, and NA336581 and subsequent.

7. EFFECT OF CHANGE ON SPECIFICATION CONTENT:

As noted.

Page 68	Figure 1	Attachment I
69	2	II
71	4	III

NOTE: Figures 1, 2, and 4 which were issued as Attachments I through III to SCN2 dated 16 September 1963 are to be retained for use with SCN2 (revised) dated 17 September 1964.

Form 608-B-8

R-3953S

MODEL SPECIFICATION
LIQUID PROPELLANT ROCKET ENGINE
ROCKETDYNE MODEL YLR101-NA-15
(VERNIER)

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.
6633 CANOGA AVENUE
CANOGA PARK, CALIFORNIA

PREPARED BY

B. H. McCurdy
Contract Specifications

APPROVED BY

W. J. Brennan
Chief Engineer
Liquid Rocket Engineering
Rocketdyne

NO. OF PAGES 79 & viii

REVISIONS

DATE 1 July 1963

DATE	REV. BY	PAGES AFFECTED	REMARKS

FORM R 18-G (PLATE)

NOTE

The following listed Engineering Changes describe major engineering design improvements accomplished on the YLR101-NA-13 and continued in the YLR101-NA-15 design.

Specification Issue	ECP's	Description	Production Effectivity
1 July 1963	Original Design ECP's		NA336501 and subsequent
	MA5-44	Replacement of Vernier Engine Teflon Backup ring.	
	MA5-50	Addition of Vernier Engine Hydraulic Return Fitting.	
	MA5-67R2	Elimination of Interference of the V.E. Gimbal Shaft Assembly and GD/A Cover Plate Assembly.	
	MA5-79	Removal of Vernier Engine Instrumentation Plug Chain.	
	MA5-31R2	Installation of Sustainer and Vernier Thrust Chamber Hypergolic Ignition System.	

The YLR101-NA-15 (Vernier) engine defined by this specification incorporates the above listed engineering changes which give it a baseline configuration of YLR101-NA-15 MD Basic.

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TABLES

LIST OF ILLUSTRATIONS

1. SCOPE

1.1 Scope.- This specification covers the requirements for the YLR101-NA-15 rocket engine.

1.2 Classification.- The rocket engine is a calibrated, fixed-thrust bipropellant rocket engine with a nominal sea-level tank-fed rating of 525 pounds. The single thrust chamber shall be gimbal mounted, shall have an exhaust-nozzle expansion ratio of 5.6:1, and shall be regeneratively cooled using the fuel as the heat transfer medium. The propellants shall be supplied to the thrust chamber from the YLR105-NA-7, not a part of this specification.

1.2.1 Function.- The rocket engine is designed to operate in conjunction with the YLR89-NA-7 and the YLR105-NA-7, not a part of this specification. The interrelation of these rocket engines is shown in Figures 5 through 10.

2. APPLICABLE DOCUMENTS

2.1 Applicable documents.- The following documents of the exact issue shown form a part of this specification, to the extent specified herein:

MILITARY

MIL-E-5149A 26 March 1956	Engine, Rocket, Liquid Propellant, General Specification for
MIL-H-5606A 21 February 1957	Hydraulic Fluid, Petroleum Base, Aircraft and Ordnance
MIL-P-25508D 16 March 1962	Propellant, Oxygen
MIL-R-25576B (USAF) 23 January 1959	Rocket Fuel, RP-1
MIL-P-27401A 7 November 1960	Propellant, Nitrogen, Pressurizing
MIL-D-70327 27 March 1962	Drawings, Engineering and Associated Lists

AIR FORCE - NAVY AERONAUTICAL BULLETIN

No. 543k 6 February 1959	Specifications and Standards Applicable to Aircraft Engines and Propellers, Use of
No. 438a 16 March 1959	Age Controls for Synthetic Rubber Parts

AIR FORCE DOCUMENTS

AFBM Exhibit 58-20A 1 December 1960	Gas, Fluid and Electrical Conduit Line Identification for Use in Missiles and Space Systems
AFBSD Exhibit 61-3A 1 September 1961	Specification for Permissible Contamination Limits and Inspection Criteria for Liquid Oxygen, Liquid Nitrogen, Fuel, Gaseous Oxygen, Gaseous Nitrogen, Instrument Air and Helium, Components, Handling Systems and Fluids Use Limits.

2.1 (Continued)

ROCKETDYNE DOCUMENT

R-3469 18 July 1962	Associate System Contractor Responsibility for Use With Rocketdyne Propulsion Systems Contracts

SPACE TECHNOLOGY LABORATORIES

GM 6300.8-565B 2 February 1962	Contamination Limits and Evaluation Methods for Hydraulic Systems and Components, WS-107A-1, Weapon System.

3. REQUIREMENTS

3.1 General.-

3.1.1 Model specification.- The model specification has been prepared using MIL-E-5150 as a guide with applicable provisions of MIL-E-5149 incorporated. Publications referenced in the model specification and contained in ANA Bulletin 343 shall be applicable as provided by the bulletin. Where the requirements of this model specification and those of the documents listed in Section 2 are at variance, the requirements of the model specification shall govern.

3.1.2 Qualification and acceptance.- The qualification and acceptance of any engine shall be in accordance with the tests specified in Section 4 of this specification.

3.2 Mockup.- The contractor shall prepare a full-scale mockup of the rocket engine when required by contract.

3.2.1 Rocket engine changes.- The Using Service shall be notified of changes to the rocket engine features affecting the installation made after approval of a mockup or the drawing package specified in paragraph 3.5. Any mockup specifically required by contract shall be kept current with approved changes for the duration of the production contract, unless otherwise authorized. Changes required by the procuring activity shall be subject to negotiations.

3.3 Performance characteristics.- The ratings, data, and curves shown are based on standard sea-level static conditions, unless otherwise noted.

3.3.1 Rocket engine operating regimes.-

3.3.1.1 Altitudes and temperatures.- The rocket engine shall start, operate, and stop throughout the design range specified herein under the following conditions:

3.3.1.1.1 Static exposure.- The dry rocket engine shall not suffer any detrimental effects when exposed, in a nonoperating condition, to a temperature range of minus 65 to plus 160 F.

3.3.1.1.2 Operation.- The rocket engine shall operate for the rated duration and stop satisfactorily at any altitude, and shall start at any altitude up to 10,000 feet provided that it is within the ambient temperature range of minus 30 to plus 130 F at start. Fluids shall be supplied within the following temperature ranges: Fuel at plus 32 to 80 F and liquid oxygen at a maximum of 50 F above the ambient sea-level boiling point for start, and liquid oxygen at a maximum of 25 F above the ambient sea-level boiling point for continued engine operation.

3.3.1.2 Attitudes.- The rocket engine shall start with the thrust chamber directed aft within a cone having a half-angle of 30 degrees when referenced from the vertical, and shall operate and stop satisfactorily throughout any flight path.

3.3.2 Ratings.- The performance ratings, established at nominal rated thrust, shall be as listed in Table I. The ratings are based on a fuel density of 50.48 lb/ft^3, and an oxidizer density of 70.73 lb/ft^3.

3.3.2.1 Duration.- The rated pump-fed duration shall be 300 seconds. The rated tank-fed duration shall be 25 seconds.

3.3.3 Estimates.- The estimated nominal pump-fed and tank-fed altitude performance, propellant flow rate, specific impulse, and thrust are shown in Figure 1. Pump-fed performance estimate is based upon the propellants being supplied at constant pressure and densities to the engine inlets as follows:

Figure 1 YLR101-NA-15 with YLR105-NA-7

Fuel density	50.48	lb/ft^3	LOX density	70.73	lb/ft^3
Fuel pressure	529	psia	LOX pressure	504	psia

3.3.4 Components.- Curves shown in Figures 2 to 4 inclusive shall constitute a part of this specification.

3.3.4.1 Thrust chambers.-

(a) Figure 2, Estimated sea-level thrust and thrust coefficient vs chamber nozzle stagnation pressure.

(b) Figure 3, Estimated characteristic velocity vs sea-level thrust.

(c) Figure 4, Estimated sea-level specific impulse vs thrust.

3.3.4.2 Pumps.- Not applicable.

TABLE I

YLR101-NA-15 RATING AT STANDARD SEA-LEVEL STATIC CONDITIONS

	Engine thrust lbs (a)	Engine instantaneous specific impulse seconds, min. (b)	Engine altitude (0 psia ambient) specific impulse, seconds, calculated min. (b)	Engine altitude (0 psia ambient) thrust, pounds, calculated minimum	Nominal chamber pressure, psia	Engine mixture ratio O/F	Engine inlet pressures, psia	
							Fuel	Oxidizer
Tank-fed	550 Max. 525 500 Min.	171	221	698	207	1.80 ± 4%	400	400
(c) Pump-fed	669	187	233	842	249	1.72	529	504

(a) Engine thrust considered parallel to thrust chamber axis. The engine thrust values are corrected to rated engine inlet conditions.

(b) The average specific impulse of an individual engine, corrected to rated thrust, mixture ratio, and engine inlet conditions, shall be equal to or greater than the minimum specified.

(c) The pump-fed ratings are estimated and are for reference only.

3.3.5 Starting.- The rocket engine is capable of being ground started. Ground support equipment in conjunction with YLR105-NA-7 and the YLR89-NA-7 or their simulated equivalents, not a part of this specification, must be utilized to effect ground starting. The start system, not a part of this specification, provides for one start only without reservicing. The start sequence is as set forth in Figure 5.

3.3.6 Shutdown.- Provisions incorporated for rocket engine cutoff shall ensure that a positive and safe shutdown can be reliably achieved under all normal operating conditions. The shutdown sequence is as set forth in Figure 10.

Normal shutdown.- The cutoff sequence is initiated by the receipt of a cutoff signal from the YLR105-NA-7, not a part of this specification.

3.3.7 Malfunction.- Supplied with specification propellants the rocket engine shall, under any single condition of malfunction, start and operate in a stable, safe, and reliable manner, or shutdown without presenting a hazardous condition that could cause damage to the vehicle, except that malfunction may be restricted or eliminated after set performance has been attained, and except that the malfunction shutdown sensing circuit shall be eliminated after the missile is irretrievably committed for flight. Malfunctions include but are not limited to events such as: power control malfunction, external power interruption or fluctuation, or fortuitous subjection to conditions exceeding specified operating parameters. Subject to the approval of the procuring activity, where it is found that certain malfunction conditions exist that cannot be overcome without compromising overall

3.3.7 (Continued)

operation, malfunctioning shall be reduced to a minimum by designing and developing into each control element the best attainable reliability or by utilizing appropriate checkout procedures. When required by contract, an analysis of pertinent malfunction conditions anticipated in service usage as agreed upon by the procuring activity and the contractor shall be prepared as a separate report. This analysis shall show that the rocket engine design has fulfilled the safety requirements as specified in this paragraph and shall be submitted to the procuring activity prior to performance of "Rocket engine inspections and test" of Specification MIL-E-5151 and MIL-E-6626.

3.3.8 External power.- External power shall be available to the rocket engine.

3.3.8.1 Pneumatic requirements.- Helium, for actuation of the propellant valves, shall be provided by YLR105-NA-7, not a part of this specification.

3.3.8.2 Electrical requirements.- Electrical power in accordance with Specification MIL-E-7894 at the following input requirements:

Direct-current power requirements are furnished by the YLR105-NA-7, not a part of this specification.

AC Components.- Not applicable.

3.3.8.3 Hydraulic power.- Not applicable.

3.3.9 Propellants and fluids.-

3.3.9.1 Propellants.-

(a) Oxidizer.- Liquid oxygen conforming to MIL-P-25508 and meeting the purity requirements of AFBSD Exhibit 61-3A as implemented by Rocketdyne Report R-3469, Section I.

(b) Fuel.- Rocket engine fuel, Grade RP-1, conforming to MIL-R-25576 and meeting the purity requirements specified in AFBSD Exhibit 61-3A as implemented by Rocketdyne Report R-3469, Section I.

3.3.9.2 Pressurizing gas.- Not applicable.

3.3.9.3 Lubricants.- Not applicable.

3.3.9.4 Other fluids.-

3.3.9.4.1 Pyrophoric fluid.- Pyrophoric fluid supplied in a container shall be used to establish thrust chamber ignition.

3.3.9.4.2 Hydraulic fluid.- Hydraulic fluid shall be supplied to the engine hydraulic flow passages from the vehicle within the range of 2500 to 3000 psia at a temperature range of plus 50 to plus 275 F. Hydraulic fluid shall be in accordance with MIL-H-5606 and shall meet the purity requirements of Space Technology Laboratories' document GM 6300.8-565B as implemented by Rocketdyne Report R-3469, Section V.

3.3.9.5 Leakage.- External or internal leakage of the fluids shall not be permitted where such leakage will impair proper functioning of or cause damage to the rocket engine or the missile and its components or will endanger personnel. Leakage limits shall be as shown on the applicable drawings of paragraph 3.5.

3.3.10 Control.-

3.3.10.1 Accuracy.- The control shall be such that the rocket engine shall operate within the limits specified in paragraph 3.3.2.

3.3.10.1.1 Mixture ratio.- The mixture ratio shall be controlled within safe operating limits during mainstage operation and during thrust increase and decrease. The safe operating mixture ratio limits are specified as 1.5 to 2.1.

(1) Pump-fed operation: The YLR101-NA-15 mixture ratio shall be dependent upon the YLR105-NA-7 mixture ratio as it varies to comply with the requirements of the propellant utilization system.

(2) Tank-fed operation: Mixture ratio limits shall be as specified in Table I.

3.3.10.2 Thrust.- There are no intermediate controlled-thrust settings.

(1) Estimated Pump-fed operation: The thrust specified as estimates in Figure 1 and the variation shall be dependent upon the YLR105-NA-7 mixture ratio as it varies to comply with the requirements of the propellant utilization system.

(2) Tank-fed operation: Thrust limits shall be as specified in Table I.

3.3.10.2.1 Change rate.- The transition change rate for the YLR101-NA-15 from tank-fed to pump-fed and pump-fed to tank-fed shall not cause malfunction of the YLR101-NA-15.

3.3.10.2.2 Increase.- The time interval between "auxiliary systems complete" and 90 percent of rated tank-fed thrust shall not exceed 5.0 seconds.

3.3.10.2.3 Decrease.- The control system in conjunction with the YLR105-NA-7, not a part of this specification, shall provide the following cutoff impulse:

Delay circuit inactive	Delay circuit active
min. 55 lb-sec	min. 75 lb-sec
max. 105 lb-sec	max. 143 lb-sec

3.3.10.3 Stability.- Thrust oscillation during transient conditions shall not produce thrust peaks of greater than 110 percent of rated thrust at frequencies below 150 cycles per second. Superimposed on this fundamental frequency may be high-frequency oscillation above 150 cycles per second and not greater in magnitude than plus or minus 3 percent of rated thrust.

3.3.10.4 Starting.-

3.3.10.4.1 Procedure.- The starting procedure shall be as specified in paragraph 3.3.5.

3.3.10.4.2 Time.- Not applicable.

3.3.10.5 Shutdown.-

3.3.10.5.1 Procedure.- The shutdown procedure shall be as specified in paragraph 3.3.6.

3.3.10.5.2 Time.- The thrust decay shall be as specified in paragraph 3.3.10.2.3.

3.3.10.6 Auxiliary function.- Not applicable.

3.4 Environmental and load factors.-

3.4.1 Environmental conditions.- The rocket engine shall not suffer any detrimental effects during and after any condition of environment that has been demonstrated by the environmental tests of paragraph 4.2.3.

3.4.1.1 Temperature range.- The rocket engine under field storage conditions, in the protective container, shall not suffer any detrimental effects when exposed to the temperature range of minus 65 to plus 160 F.

3.4.1.2 Vibration.- The rocket engine shall withstand all vibration encountered in normal usage without deleterious effect on the rocket engine or impairment of its serviceability.

3.4.2 Flight and ground loading conditions.- The rocket engine and its supports shall withstand, without permanent deformation or failure, the largest forces resulting from all critical combinations of load factors specified in paragraphs 3.4.2.3 and 3.6.6. For design purposes, the ultimate strength shall provide for a minimum of 1.5 times the forces resulting from the loading conditions. The rocket engine shall be designed to withstand 4.0 g handling loads applied in any direction. Demonstration of these requirements may be waived at the discretion of the procuring activity when acceptable substantiating analytical data are furnished by the contractor.

3.4.2.1 Aircraft rocket engines.- Not applicable.

3.4.2.2 Aircraft launched missile rocket engines.- Not applicable.

3.4.2.3 Vehicle rocket engines.- The rocket engine and its supports, while meeting the gimbaling requirements of paragraph 3.6.6, shall operate satisfactorily, without permanent deformation or failure, under any one of the following load conditions:

(a) 12.0 g's parallel to the direction of flight and 1.25 g's perpendicular to the direction of flight

(b) 10.0 g's parallel to the direction of flight and 1.5 g's perpendicular to the direction of flight

(c) 2.5 g's parallel to the direction of flight and 3.0 g's perpendicular to the direction of flight.

3.4.3 Limiting zone temperatures.- No heating or cooling provisions are required by the engine during flight.

3.5 Drawings and data.- The Rocketdyne drawings and data listed below shall form a part of this model specification:

MODEL IDENTIFICATION NUMBERS

Engine and Model Parts List (MPL)	MD Numbers
YLR101-NA-15	Basic

	SUBJECT	Number
(a)	Engine assembly - vernier complete	351000
(b)	List loose equipment	351030
(c)	Thrust chamber and gimbal installation	351005
(d)	Orifices and accessories installation	351010
(e)	Feed system installation	351015
(f)	Electrical system installation	351020
(g)	Customer connect	351025

3.5.1 Before contract.- Not applicable.

3.5.2 After contract.- Not applicable.

3.5.3 Weights.- The dry weight of the YLR101-NA-15 shall not exceed 54 pounds. The wet weight after normal shutdown shall not exceed 56 pounds. The wet weight with all systems filled to capacity shall not exceed 57 pounds.

Assembly	Estimated Weight, lb
Thrust chamber	15
Mount and bearing assembly	27
Oxidizer system	5
Fuel system	3
Electrical system	2
Ignition system	2
Dry weight	54

3.5.4 Overall dimensions.- The overall dimensions of the rocket engine shall be as shown on the applicable drawings of paragraph 3.5.

3.6 Components and systems.-

3.6.1 Propellant and other fluids systems.- The rocket engine shall function satisfactorily when the propellants and other fluids are supplied within the following conditions: Fuel at start and continued operation, shall be at plus 32 to 80 F. Liquid oxygen at start shall be at a maximum of 50 F above the ambient sea-level boiling point. Liquid oxygen for continued engine operation shall be at a maximum of 25 F above the ambient sea-level boiling point. Other fluids must be in accordance with paragraph 3.3.9.

3.6.1.1 Pump and drive system.- Not applicable.

3.6.1.1.1 Turbine exhaust connection.- Not applicable.

3.6.1.2 Fluid drainage.- Not applicable.

3.6.1.3 Lines and fittings.- The minimum and maximum torque values shall be as specified in Drawing AND10064 for the sizes or types of lines and fittings except as specified on the contractor's drawings.

3.6.1.4 Filters.- Filters shall be as shown on applicable drawings of paragraph 3.5 and shall be of a design and fabrication that will not permit passage of solid impurities which will affect engine operation when fluids are supplied within the limits of paragraph 3.3.9.

3.6.1.5 Filler connections.- Not applicable.

3.6.2 Power control.- The controls shall provide for starting, operating, and stopping the rocket engine in accordance with the requirements of this model specification. During full-thrust operation at standard sea-level static conditions, the design requirements of the controls shall be to maintain performance as shown in Table I.

3.6.2.1 Preflight check.- Preflight check shall be obtained through the ground support equipment, not a part of this specification. All control circuits may then be checked by direct or simulated operation.

3.6.2.1.1 External test connections.- Noninterchangeable test connections, as required for safety, shall be provided for ground checking of significant sequencing and emergency devices. Details of the connections shall be presented on the installation drawings.

3.6.2.2 Indication.- Switches shall be provided on the rocket engine to give an indication of full-open and full-closed positions of the main propellant valves. A pressure switch will be provided to indicate effective mainstage thrust.

3.6.2.3 Calibration.- All field replaceable controls shall have the capability of being installed and used without field calibration.

3.6.2.4 Interrelation with rocket engine.-

(a) The "Power control arrangement" is as shown in Figure 7.
(b) The "Sequence of rocket engine operation" is as shown in Figures 5 and 6.

3.6.2.4.1 Performance selector (For aircraft).- Not applicable.

3.6.2.5 Starting.- The starting sequence shall be automatic upon initiation by ground support equipment, not a part of this specification.

3.6.2.5.1 Fixed thrust rocket engines.- Not applicable.

3.6.2.5.2 Variable thrust rocket engines.- Not applicable.

3.6.2.6 Control adjustment.- Not applicable.

3.6.3 Electric system.-

3.6.3.1 Electrical power.- All components using electrical power from the vehicle power system shall be consistent with the requirements of 3.3.8.2 herein.

3.6.3.2 Radio interference.- Not applicable.

3.6.3.3 Ignition proof.- Electrical components shall not ignite any explosive mixture surrounding the equipment.

3.6.3.4 Connectors and cable.- It shall be possible to connect or disconnect electrical connectors and to flex electrical conductors as necessary for routine maintenance without damage, at a temperature of minus 65 F. All electrical wiring shall be capable of withstanding 400 F for the rated duration without causing malfunction.

3.6.4 Ignition system.- The ignition system shall consist of a pyrophoric fluid-filled, pressure-actuated container used in a hypergolic application.

3.6.4.1 High-tension lead assembly.- Not applicable.

3.6.5 Lubrication system.- Not applicable.

3.6.6 Thrust chamber assembly.- The thrust chamber shall be gimbaled to permit thrust chamber movement as follows. Gimbaling actuators shall not be furnished with the engine.

3.6.6 (Continued)

(a) The minimum angle of displacement of the effective thrust vector shall be plus or minus 70 degrees in pitch and plus 30 degrees and minus 20 degrees in yaw as measured on the respective protractors.

(b) The engine shall be capable of withstanding a maximum actuator force of 2000 pounds on an arm of 1.25 inches from the gimbal axis. The moment of inertia of the gimbal components shall be such that when a force of 1350 pounds is applied on an arm of 1.25 inches, the thrust chamber shall be accelerated at a minimum of 4000 deg/sec^2, under any combination of gimbal friction, lateral acceleration, and thrust alignment as specified herein.

(c) Gimbal friction shall not exceed 35 ft-lb in the yaw gimbal plane and 75 ft-lb in the pitch gimbal plane. (Includes actuator friction.)

(d) The rocket engine shall be capable of being continually dry gimbaled at one (1) cycle per second for five (5) minutes without producing conditions resulting in leakage under wet gimbaling operation.

3.6.6.1 Propellant accumulation.- Propellants remaining in the rocket engine after shutdown are as specified in paragraph 3.5.3.

3.6.7 Tanks.- Not applicable.

3.6.8 Burst diaphragms.- Burst diaphragms are provided in thrust chamber igniter cartridges.

3.6.9 Accessory drives.- Not applicable.

3.6.10 Accessory equipment.- Not applicable.

3.7 Fabrication.-

3.7.1 Materials.-

3.7.1.1 Quality.- Materials used in the manufacture of the rocket engine shall be of high quality, suitable for the purpose, and shall conform to applicable specifications in accordance with ANA Bulletin No. 343. When contractor's specifications are used for materials which may affect performance or durability of the rocket engine, such specifications will be released to the Government prior to the Qualification tests. The use of non-Governmental specifications shall not constitute waiver of Government inspection.

3.7.1.2 Critical materials.- The use of critical materials shall be held to a minimum. The list of critical materials noted in paragraph entitled "Critical materials" of Specification MIL-E-5149A, and the estimated weights thereof based on the finished parts are as follows:

	Material	Weight, pounds
(a)	Chromium	1
(b)	Cobalt	0
(c)	Columbium	0
(d)	Molybdenum	0
(e)	Natural rubber	0
(f)	Nickel	1
(g)	Tungsten	0

3.7.2 Processes.-

3.7.2.1 Quality.- When contractor's specifications are used for processes which may affect performance or durability of the rocket engine, such specifications will be released to the Government prior to the Qualification tests. The use of non-Governmental specifications shall not constitute waiver of Government inspection.

3.7.2.2 Workmanship.- The workmanship and finish shall be of sufficiently high grade to ensure satisfactory operation, reliability, and durability consistent with the service life and application of the rocket engine.

3.7.2.3 Interchangeability.- All parts having the same manufacturer's part number shall be directly and completely interchangeable with respect to installation and performance except that matched parts or selective fits will be permitted where required. Changes in manufacturer's part numbers shall be governed by the drawing number requirements of Specification MIL-D-70327.

3.7.2.4 Protective treatment.- With the exception of working surfaces and drive pad faces, all parts shall be corrosion resistant or suitably protected.

3.7.3 Standards.-

3.7.3.1 Parts.- AN, JAN, or MIL Standard parts shall be used wherever they are suitable for the purpose, and shall be identified by their Standard part numbers. The use of nonstandard parts will be acceptable only when standard parts have been determined to be unsuitable.

3.7.3.2 Design.- MS and AND Design Standards shall be used wherever applicable.

3.7.3.3 Threads.- Conventional straight screw threads shall conform to the requirements of Specification MIL-S-7742. Tapered pipe threads may be employed only for permanently installed fittings or plugs.

3.7.4 Parts list.- The parts list for the rocket engine which successfully completes the Preliminary Flight Rating tests shall constitute the approved parts list for subsequent engines of the same model. Changes to the approved rocket engine parts list shall be governed by the requirements specified in paragraph 3.7.5.

3.7.5 Changes in design.- Changes made in the design or materials of parts listed in an approved rocket engine parts list shall be approved in accordance with the provisions of ANA Bulletin No. 391a, as incorporated in the contract.

3.7.5.1 Class I changes.- Definitions shall be as provided in paragraph 3.7.5.

3.7.5.2 Class II changes.- Definitions shall be as provided in paragraph 3.7.5.

3.7.5.3 Approval of changes.- Approval of changes does not relieve the contractor of full responsibility for the results of such changes on rocket engine characteristics.

3.8 Identification of product.- Equipment, assemblies, and parts shall be marked for identification in accordance with MIL-STD-130. The identification data applied to the rocket engine data plate shall be as follows:

Engine, Rocket, Liquid Propellant
Government Model Designation *
Model Specification No. *
Serial No. *
Manufacturer's Part No. *
Contract or Order Number *
Manufacturer's Name or Trade-Mark *
US

* Applicable data to be entered by the contractor.

3.8.1 Connections.- All propellant and other fluid connections shall be shown on the engine installation drawing. Instrumentation connections shall be as shown on the instrumentation installation drawings. All fluid lines shall be marked in accordance with AFBM Exhibit 58-20 as implemented by Rocketdyne Report R-3469, Section VI.

3.8.2 Components.- Components shall be clearly marked as follows:

(Nomenclature)
Serial Number *
Stock Number *
Manufacturer's Part Number *
Manufacturer's Name or Trade-Mark *

* Applicable data to be entered by the contractor.

3.8.2.1 Synthetic rubber parts.- Components used in hydrocarbon fluid systems containing synthetic rubber parts shall be marked in accordance with ANA Bulletin Number 438.

3.9 General additional information.-

3.9.1 Thrust alignment.- The thrust-vector misalignment of the thrust chamber shall not exceed 2 degrees angularity and 1/8 inch lateral displacement at the gimbal point when measured from the gimbal axis.

4. QUALITY ASSURANCE PROVISIONS

4.1 Classification of tests.- The testing of liquid propellant rocket engines shall be classified as follows:

(a) Qualification tests.- The Qualification tests are conducted to demonstrate the suitability of an engine model for production.

(b) Preliminary Flight Rating tests.- The Preliminary Flight Rating tests are conducted to demonstrate the suitability of an engine model for use in experimental aircraft or missile flight testing.

(c) Acceptance tests.- The acceptance tests are conducted on engines submitted for acceptance under contract.

(1) Miscellaneous inspection tests.- Various inspection tests and procedures are conducted during the course of manufacture to ensure that adequate quality control is maintained for materials and manufacturing purposes.

4.2 Tests and test methods.-

4.2.1 Alternate test fluids.- Cold calibration.

TABLE II

ALTERNATE TEST FLUIDS

Specified propellant or fluid	Alternate test fluid
Liquid oxygen	Liquid nitrogen or water
RP-1	Water
Helium	Dry nitrogen

4.2.2 Qualification tests.- Qualification test requirements shall be as specified by Specification MIL-E-5151, as modified by mutual agreement of the procuring activity and the contractor. Demonstration of these requirements shall be as required by contract.

4.2.3 Preliminary Flight Rating tests.- Establishment of a Preliminary Flight Rating for the rocket engine is predicated on prior satisfactory completion of the tests on the MA-2 propulsion system in accordance with Specification MIL-E-6626, except as modified or reiterated hereafter with paragraph numbers identified by (6626).

1. (6626) SCOPE

1.1 (6626) This specification establishes Preliminary Flight Rating test requirements for approving the use of a liquid-propellant rocket engine in a vehicle under restricted usage conditions.

2. (6626) APPLICABLE DOCUMENTS

2.1 (6626) The applicable publications listed in the following bulletin, of the issue specified in the manufacturer's engine model specification, form a part of this specification:

PUBLICATIONS

Air Force - Navy Aeronautical Bulletin

No. 343 Specifications and Standards Applicable to Aircraft Engines and Propellers, Use of

3. (6626) REQUIREMENTS

3.1 (6626) Reports: rocket engine and components.- Report shall be prepared as follows:

3.1.1 (6626) General.-

3.1.1.1 (6626) Dimensional units.- Unless otherwise specified, all dimensional units shall be expressed in the English gravitational system of units.

3.1.1.2 (6626) Corrections.- Performance characteristics shall be corrected in accordance with the contractor's data reduction method. The performance characteristics shall be based on measurements obtained during a short time-interval at a stabilized point. The aforementioned conditions shall also be acceptable to the procuring activity.

3.1.1.3 (6626) Summary data sheets.-

3.1.1.3.1 (6626) Limits.- Performance limits and bench setting limits shall be superimposed on all summary curves. Performance limits shall be defined as the envelope of the curves which will give the rocket engine performance specified in this model specification.

3.1.1.3.2 (6626) Title block.- Each curve sheet or data plot shall contain the following information in a title block substantially in accordance with Figure 1 of MIL-E-6626A.

3.1.1.3.2 (Continued)

(6626)

(a) Title (of summary)
(b) Component (nomenclature)
(c) Manufacturer (of component)
(d) Part No. (of component)
(e) Serial No. (of component)
(f) Test numbers (or original data sheets or curves from which summary curves are plotted)
(g) Date
(h) Prepared by; approved by
(i) Contract No.
(j) Report No.
(k) Page No.
(l) Figure No.
(m) Contractor
(n) Testing activity
(o) Used on

3.1.1.3.3 (6626) Data block.- Test constants and other test data not recorded in the title block shall be recorded in a separate block substantially in accordance with Figure of MIL-E-6626A.

3.1.2 (6626) Preliminary reports.- Immediately following completion of the engine tests and each separate component test, or consecutive group of tests conducted on any single test assembly or components, a brief report may be requested by the procuring activity. This report, combined with the certificate of a Government representative as to the proper conduct of the tests and the factual accuracy of the report may, at the discretion of the procuring activity, constitute the basis for approval of the tests.

3.1.2.1 (6626) Preparation.- Preliminary reports shall contain essentially the following information:

(a) General summary of test, giving dates, failures, test incidents, performance changes, marginal conditions, etc.

(b) Description of the condition of the engine or components, or both, at disassembly inspection.

(c) Recommendations with respect to approval of the engine or components, or both, supplemented by such discussion as is necessary for their justification.

3.1.3 (6626) Final report.- Following completion of all tests required herein, a final report shall be submitted which will constitute a record of all information pertaining to the tests. This report will normally be used as a basis for approval of the Preliminary Flight Rating tests. The final report shall contain the following items.

3.1.3.1 (6626) Title page.-

3.1.3.2 (6626) Table of contents.-

3.1.3.3 (6626) Object.-

3.1.3.4 (6626) Summary.- (A brief summary of each of the tests conducted, giving the title of each test, the item tested, dates of testing, and a general statement of the results. References shall be made to the applicable preliminary reports.)

3.1.3.5 (6626) Conclusions and recommendations.-

3.1.3.6 (6626) Appendixes.- Each appendix shall cover a single test or group of consecutive tests conducted on any single test assembly or component, and shall report all test runs, and shall contain the following items.

3.1.3.6.1 (6626) (Brief general description of the rocket engine or of the components and a detailed description of all features which differ from the previous model, if applicable.)

3.1.3.6.2 (6626) Method of test (General description and schematic diagram of test equipment, methods, and measurement locations used in conducting the test.)

3.1.3.6.3 (6626) Record of test (Chronological history of all events in connection with all the testing. The chronological history shall be presented in a graphical or equally acceptable form showing mid-point values of data as specified in paragraph (6626) 3.1.3.6.5.1.1.2. Failures, parts replacement, and other items of interest shall be noted.)

3.1.3.6.4 (6626) Analysis of results (A complete discussion of all phases of the tests, such as probable reasons for failure and unusual wear, comparison in performance with previous models, and analysis of general operation.)

3.1.3.6.5 (6626) Data.- Copies of specified data shall be furnished. (Where time functions are not originally recorded in curve form, the data shall be tabulated or plotted.)

3.1.3.6.5.1 (6626) Rocket engine test.-

3.1.3.6.5.1.1 (6626) Specified data.- The following data may be furnished as rocket engine data for tests performed under missile simulated conditions, and as individual engine data under all other test conditions.

3.1.3.6.5.1.1.1 (6626) Original data.- Copies of original and reduced data shall be furnished for those cases in which transient effects are significant. In other cases, only reduced data shall be furnished. These data shall include but not be limited to the following:

YLR101-NA-15 engine

(a) Total oxidizer flow rate vs time
(b) Total fuel flow rate vs time
(c) Chamber pressure vs time

3.1.3.6.5.1.1.2 (6626) Derived data.- The derived data, based on data obtained at a stabilized point during a short time interval, shall include but not be limited to the following:

(a) Specific impulse
(b) Mixture ratio
(c) Thrust
(d) Chamber pressure
(e) Effective duration (not to be derived from short time interval data)

3.1.3.6.5.1.1.3 (6626) Derived curves.-

3.1.3.6.5.1.2 (6626) Test data.- Test data shall include but not be limited to the following.

3.1.3.6.5.1.2.1 Weight test.- The weight of the rocket engine determined during the Acceptance test shall be noted in the test report.

3.1.3.6.5.1.2.2 (6626) Static leakage test.-

3.1.3.6.5.1.2.3 (6626) Drainage test.-

3.1.3.6.5.1.2.4 (6626) Vibration test.- Wherever responses of components to the forcing vibrations are measured, the resonant frequencies and affected components shall be noted.

3.1.3.6.5.1.2.5 (6626) Calibration test.- Data as specified in paragraph (6626) 3.1.3.6.5.1.1 shall be furnished for the first, mid-point, and last test run.

3.1.3.6.5.1.2.6 (6626) Variable thrust test.- Not applicable.

3.1.3.6.5.1.2.7 (6626) Safety limits.- Data as specified in paragraph (6626) 3.1.3.6.5.1.1.1 shall be furnished where applicable for each malfunction test and for the first, mid-run, and last start-shutdown test.

3.1.3.6.5.1.2.8 (6626) Environmental test.- Not applicable.

3.1.3.6.5.2 (6626) Rocket engine component test.-

3.1.3.6.5.2.1 (6626) Power control test.- Test data shall include but not be limited to the following.

3.1.3.6.5.2.1.1 (6626) Altitude.-

3.1.3.6.5.2.1.2 (6626) Ignition-proof.-

3.1.3.6.5.2.2 (6626) Individual thrust-chamber assembly test.- Test data shall include but not be limited to the following.

3.1.3.6.5.2.2.1 (6626) Original data.- Copies of original and reduced data shall be furnished for those cases in which transient effects are significant. In other cases, only reduced data shall be furnished. The data to be furnished shall be specified in this model specification. These data shall be sufficient to substantiate conformance with requirements for stable, safe, and reliable thrust chamber assembly operation.

3.1.3.6.5.2.2.2 (6626) Derived curves.- The following curves, in accordance with paragraph (6626) 3.1.1.2, shall be presented:

(a) Thrust vs chamber pressure
(b) Thrust coefficient vs chamber pressure
(c) Specific impulse vs chamber pressure.

3.1.3.6.5.2.3 (6626) Tank tests.-

3.1.3.6.5.3 (6626) Other data.- The Acceptance Test Log, as defined in paragraph (5152) 3.2.2 for the Preliminary Flight Rating test engine shall be included in the Preliminary Flight Rating test final report.

3.1.4 (6626) Number and distribution of copies.- Six copies of the Preliminary Flight Rating test report, one copy of which shall be reproducible, shall be forwarded to the procuring activity.

3.2 (6626) Disposition of Preliminary Flight Rating test data.- Preliminary Flight Rating test data shall be retained by the contractor for two years and furnished to the procuring activity or authorized representative upon request.

4. (6626) QUALITY ASSURANCE PROVISIONS

4.1 (6626) General.- Liquid propellant rocket engines, components, and test apparatus shall be subject to inspection by authorized Government Inspectors. All tests outlined in this specification shall be subject to witnessing by representatives of the contractor and the procuring activity. Two copies of the complete parts list and specifications for all components of the flight rating test engine shall be furnished to the procuring activity prior to beginning the Preliminary Flight Rating tests. The drawings, prior to and during the Preliminary Flight Rating tests, shall be at the disposal of the authorized Government Inspectors. At convenient times prior to the tests and after the tests, the rocket engine and components shall be examined to determine if they conform to all requirements of the contract and specifications under which they were built. At the option of the procuring activity,

4.1 (Continued)

(6626) measurements shall be made of critical engine dimensions prior to start of the Preliminary Flight Rating tests. During the progress of tests, examinations may be made at the option of the procuring activity. The results of all such examinations shall be submitted as part of the Preliminary Flight Rating test data.

4.1.1 (6626) Test apparatus and procedures.- Schematic drawings and descriptions of all test apparatus and outline diagrams showing points of the measuring apparatus and its application shall be furnished prior to initiation of the Preliminary Flight Rating test. The plumbing runs to the YLR101-NA-15 shall simulate the missile installation. Any deviations from missile installation simulation shall be approved by the procuring activity. Test procedures and methods to be used shall be acceptable to the procuring activity.

4.1.1.1 (6626) Instrument calibration.- Each instrument and other measuring apparatus upon which the accuracy of test results depends shall be calibrated frequently enough to ensure attainment of steady-state accuracy of plus or minus 3 percent of the specified value of measurement, except where greater accuracy is required to demonstrate the model specification requirements. Calibration records shall be maintained and shall be made available to authorized representatives of the procuring activity or of the contractor upon request.

4.1.1.2 (6626) Automatic recording equipment.- Automatic recording equipment of adequate response shall be used to obtain data during transient conditions of engine and component operation requiring the evaluation of time versus engine variables.

4.1.2 (6626) Test conditions.- Unless otherwise specified, all inspections and tests shall be conducted at room temperature, as defined in paragraph (6626) 4.1.2.1.2 entitled, "Room temperature", and at ambient pressure. The YLR101-NA-15 engine performance shall be corrected to the engine inlet pressures of paragraph 3.3.2, Table I. Engine purges used in the tests shall simulate the engine purges as required for missile captive tests. Ground support equipment, consisting of ground electrical control console, and ground electrical box or acceptable equivalent shall be used to simulate operational procedures on engine firing. Test facility systems and equipment shall be used to simulate operational checkout procedures as closely as possible, while maintaining maximum information of engine condition prior to each test firing.

4.1.2.1 (6626) Temperatures.-

4.1.2.1.1 (6626) Low temperatures.- Not applicable.

4.1.2.1.2 (6626) Room temperature.- Room temperature limits are as follows: (a) Fuel at plus 32 to plus 80 F, (b) hydraulic fluid at plus 50 to 110 F, (c) ambient air and other test fluids at plus 10 to plus 110, except:

(1) When the test fluid boiling point is below plus 10 F, the fluid shall be allowed to remain at the temperature encountered under test conditions.

(2) When the test fluid freezing point is above plus 10 F, the fluid shall be maintained at 10 F above its freezing point unless otherwise specified in the model specification.

4.1.2.1.3 (6626) High temperature.- Not applicable.

4.1.3 (6626) Parts failure and replacement.- Maintenance, adjustment, or replacement of parts other than described in preflight checkout shall not be permitted during testing, except as mutually agreed upon between the contractor and the procuring activity.

4.1.3.1 (6626) Rocket engine.- If, during the Preliminary Flight Rating test of the engine, a part fails, this part may be replaced or a new Preliminary Flight Rating test started on a new engine with a redesigned part or one of different material, unless the procuring activity authorizes the installation of a new part of original design and material for one which, in the judgment of the procuring activity, failed due to faulty material or workmanship. The Preliminary Flight Rating test on the engine shall be considered complete when every part of the engine has been subjected to, and has satisfactorily completed an entire test. At the discretion of the procuring activity, redesign and retesting may be required of any part which fails or indicates weakness after completing its Preliminary Flight Rating test but is retained in the engine to complete testing on other parts.

4.1.3.2 (6626) Components.- The above procedure shall apply in the event of parts failure during the flight rating testing of components.

4.2 (6626) Rocket engine inspections and tests.- The rocket engine to be subjected to a Preliminary Flight Rating test shall be a deliverable system, which shall be demonstrated satisfactorily by the performance of the acceptance tests of Specification MIL-E-5152A as modified by paragraph 4.2.4.

4.2.1 (6626) Rocket engine tests.- The rocket engine shall be subjected consecutively to the drainage, static leakage, vibration, calibration, and static leakage tests. Safety limits tests may be scheduled as convenient and may be performed on another identical engine which shall be subjected consecutively to the static leakage, the safety limits tests, and static leakage test. Unless otherwise specified herein, any additional tests required by the procuring activity under paragraph (6626) 4.2.1.9 shall be conducted after the safety limits tests. A minimum running time shall be accumulated, prior to the final static leakage tests, equal to 6 runs at rated duration. Rated duration shall be considered to be the duration for the complete sequence of engine operation including the vernier solo duration.

4.2.1.1 (6626) Weight.- The dry rocket engine shall be weighed, and its weight shall not exceed the value specified in the model specification.

4.2.1.2 (6626) Static leakage.- All fluid systems of the rocket engine, as specified in paragraph 3.6.1, shall be tested for leakage by pressurizing individual systems to full operating pressure wherever practicable or to the highest pressures technically feasible considering recognized safety factors. The test pressure shall start at a low differential pressure and be increased at a uniform rate to the static leakage pressure. The maximum test pressure shall be maintained for a minimum of 2 minutes. Leakage, at any time during the test, shall not exceed that specified in paragraph 3.3.9.5, drawings, and component specifications.

4.2.1.3 (6626) Drainage.- The fluid systems of the engine shall be completely filled, with the engine in a simulated launch position, then drained and purged to the maximum extent possible without firing. The fluids remaining shall be determined and shall not exceed the amounts specified in the model specification.

4.2.1.4 (6626) Vibration.- The vibration test shall consist of the calibration test runs of paragraph (6626) 4.2.1.5. Evidence of fatigue failure of any component upon completion of these tests shall be cause for rejection of the component.

4.2.1.5 (6626) Calibration.- Data shall be measured and calculated for the following tests in accordance with paragraph (6626) 3.1.3.6.5.1.2.5. When direct thrust determinations cannot be made, the thrust versus chamber pressure calibration curves presented in accordance with paragraph (6626) 3.1.3.6.5.2.2.2 (a) shall be used for indirect thrust determinations. The sequence of the rocket engine operation shall be as specified in paragraph 3.3.5 and 3.3.6.

4.2.1.5.1 (6626) Calibration tests.- During the calibration tests, measurements shall be taken that demonstrate that the rocket engine meets the following requirements: (a) the cutoff impulse, as specified in paragraph 3.3.10.2.3, and (b) the ratings of Table I of paragraph 3.3.2. Pump-fed ratings of the YLR101-NA-15 shall be demonstrated on all tests. The YLR101-NA-15 shall be required to demonstrate tank-fed performance at the conclusion of rated duration runs only. The remainder of the six (6) equivalent duration tank-fed runs shall be performed on a separate installation.

4.2.1.5.1.1 (6626) Calibration, gimbaling fixed.- Two tests shall be made at a thrust rating within the range of Table I, of paragraph 3.3.2, with the thrust chamber in the fixed position, one of which shall be at rated duration.

4.2.1.5.1.2 (6626) Calibration, gimbaling operative.- Two (2) runs shall be made on a separate installation at rated duration at a thrust rating within the range of Table I, paragraph 3.3.2, during which time demonstration of the YLR101-NA-15 gimbaling requirements of paragraph 3.6.6 shall be performed. The time accumulated on this test series shall be applicable to the total time requirement of paragraph (6626) 4.2.1.

4.2.1.5.2 (6626) Variable and multiple thrust ratings.- Not applicable.

4.2.1.6 (6626) Variable thrust.- Not applicable.

4.2.1.7 (6626) Safety limits.- A total of 20 tests shall be performed on the rocket engine. They shall consist of a sufficient number of tests to meet the requirements of paragraph (6626) 4.2.1.7.1, and the remainder shall be in accordance with paragraph (6626) 4.2.1.7.2. During any five of these tests, the rocket engine shall be operated at the high and low voltage limit for starting sequence and mainstage operation as specified in paragraph 3.3.8 (b). Two (2) tests shall be conducted at the high limit and three (3) at the low limit of the voltage range.

4.2.1.7.1 (6626) Malfunction.- The type and order of these tests shall be based on the malfunction analysis required by paragraph 3.3.7, entitled "Malfunction", and shall be included with the tests specified in paragraph (6626) 4.2.1.7 as described by the approved test procedure. Compliance with paragraph 3.3.7 shall be demonstrated after the occurence of one of the following events during either transient or stabilized operation of the rocket engines:

(a) Malfunction of rocket engine component or system.

(b) Malfunction of the vehicle system affecting rocket engine operation.

4.2.1.7.2 (6626) Start-shutdown.- The number of those tests shall be sufficient to complete the total number of tests required by paragraph 4.2.1.7. The rocket engine shall be subjected consecutively to the following:

(a) Starting cycle and sequence of events outlined in paragraph 3.3.5.

(b) Stabilized operation at a level and of sufficient duration to obtain data substantiating the requirements for stable, safe, reliable operation.

(c) Shutdown cycle and sequence of events outlined in paragraph 3.3.6.

4.2.1.8 (6626) Environmental.- Not applicable.

4.2.1.9 (6626) Additional tests.- The procuring activity may require additional tests for the purpose of testing special features of the rocket engine and propellants. These tests shall be as required and mutually agreed upon by the contractor and the procuring activity, and in general, shall not increase the total running time accumulated during the Preliminary Flight Rating test.

4.2.1.10 (6626) Preliminary Flight Rating conditions.- Preliminary Flight Rating of the rocket engine shall be predicated on maintenance of all parameters within the limits and conditions specified herein, except for the maintenance of those parameters restricted by the missile simulated configuration. Minor parts failures or malfunctions may, at the option of the procuring activity, be considered acceptable if safety is not jeopardized. The failures or malfunctions shall be recorded in accordance with paragraph (6626) 3.1.3.6.3 and submitted to the procuring activity for approval.

4.2.2. (6626) Rocket engine inspection after test.- After completion of tests of the rocket engine, the engine shall be completely disassembled for examination of all parts, measurements, and photographs taken as necessary to disclose excessively worn, distorted, or weakened parts. Calibrations shall be made of all controls and control components prior to disassembly. These calibrations shall demonstrate the components are within the design tolerance range required by the applicable specification.

4.3 (6626) Component inspection and tests.-

4.3.1 (6626) Previous component qualification.- All rocket engine components requiring flight rating inspection and test as specified herein may have these requirements waived at the option of the procuring activity, if the component has been previously qualified or has passed Preliminary Flight Rating tests at the same or higher rating for service use on another engine. The components must be substantially identical to the respective components previously qualified or flight rated with the exception of provisions for engine installation. If such a waiver is granted, information on the components for which previous approval was obtained shall be provided in the Preliminary Flight Rating test report.

4.3.2 (6626) Component inspection before tests.- All components shall be completely inspected for compliance with the contractor's drawings and specifications before Preliminary Flight Rating tests are begun. Deviations from the contractor's drawings and specifications shall be approved by a representative of the procuring activity. Defective parts shall not be used on any component or engine subjected to the Preliminary Flight Rating tests.

4.3.3 (6626) Component tests.- The following tests shall be conducted on components.

4.3.3.1 (6626) Power control tests.- Each electrical or altitude sensitive subcontrol shall be tested in accordance with the following paragraphs. A functional test shall simulate as closely as possible the entire range encountered in engine operation.

4.3.3.1.1 (6626) Altitude.- Pressure altitudes shall be as defined in the May 1954 edition of the Manual of the ICAO Standard Atmosphere - Calculations by NACA and the April 1955 draft of Appendix A, entitled, "Proposed Extension to the ICAO Standard Atmosphere, Model Ib".

4.3.3.1.1.1 (6626) Pressure sensitive subcontrol test.- Each subcontrol, sensitive to altitude, with its operating fluid or approved test fluid, shall be functionally tested for 10 cycles at a simulated pressure altitude of 200,000 feet.

4.3.3.1.1.2 (6626) Electrical subcontrol test.- Each electrical subcontrol, with its operating fluid or approved test fluid, shall be subjected to the following:

(a) The test chamber pressure shall be established at the pressure existing at a pressure altitude of 200,000 feet.

(b) Electrical power shall be applied for 10 minutes with all power sources at maximum design values.

(c) A functional test of 100 cycles, in accordance with Specification MIL-E-5151, shall be performed while the subcontrol is operated over the input range of either 18 to 29 volts dc or 102 to 124 volts ac throughout the frequency range required by the type of ac power utilized as defined in Specification MIL-E-7894.

(d) While the subcontrol is hot as a result of the functional test, a potential of 300 volts rms for relays and solenoids at commercial frequency, shall be applied between all terminals not in the same circuit and between terminals and grounded metal parts for a period of 60 seconds.

4.3.3.1.1.2 (Continued)
(6626) There shall be no "arc-over" or evidence of "arc-over" between electrical contacts, terminals, or parts of a subcontrol having a difference of potential. Current flow in excess of 2 milliamperes or breakdown of insulation shall constitute failure.

4.3.3.1.2 (6626) Ignition-proof.- Electrical subcontrols, except those specified in paragraph 4.3.6 of Specification MIL-E-5272, shall be tested in accordance with paragraph 4.13.1, Explosion Proof (Aeronautical) test, Procedure I, of that specification. The altitude increments shall be 10,000 feet and shall be from sea-level to 60,000 feet. Components which operate only at take-off shall be tested at sea level and 10,000 feet altitudes only.

4.3.3.2 (6626) Individual thrust chamber assembly tests.-
Indi

4.3.3.2.1 (6626) Injector calibration.- Not applicable.

4.3.3.2.1.1 (6626) Coolant jacket calibration.- Not applicable.

4.3.3.2.2 (6626) Calibration.- One YLR101-NA-15 thrust chamber assembly shall be calibrated at 90 percent rated thrust, 110 percent rated thrust, and one intermediate thrust. Two calibrations shall be made at each level. Standard thrust chamber assembly calibration curves, showing relationships of propellant flow rate, thrust, and thrust coefficient with chamber pressure shall be prepared from the test results. These curves, together with the best available data, shall be used to determine thrust from the chamber pressure whenever direct means of measuring thrust are not available or feasible.

4.3.3.2.3 (6626) Acceptance conditions.- Acceptance of each thrust-chamber assembly shall be predicated on the maintenance of all parameters within the limits specified in this model specification.

4.3.3.3 (6626) Tank tests.- Not applicable.

4.3.4 (6626) Component inspection after tests.- After completion of tests of the components, each component shall be completely disassembled for examination of all parts and measurements, as necessary, to disclose excessively worn, distorted, or weakened parts. These measurements shall be compared with the contractor's drawing dimensions and tolerances or with similar measurements made prior to the test when available. The results of these inspections shall be submitted as part of the Preliminary Flight Rating test data.

5. (6626) PREPARATION FOR DELIVERY (Not applicable to this specification.)

6. (6626) NOTES

6.1 (6626) Intended use.- The Preliminary Flight Rating test procedures specified herein are intended for use in the testing of liquid-propellant rocket engines.

6.2 (6626) Definitions and symbols.- The symbols and terms used in this specification and the applicable definitions are as specified in Specification MIL-E-5150A as modified herein.

4.2.4 Acceptance tests.- The Acceptance tests shall be conducted on each engine in accordance with Specification MIL-E-5152 except as modified or reiterated hereinafter with paragraph numbers identified by (5152).

1. (5152) SCOPE

1.1 (5152) This specification covers the Acceptance test requirements for the YLR101-NA-15 rocket engine.

2. (5152) APPLICABLE DOCUMENTS

2.1 (5152) The applicable publications listed in the following bulletin, of the issue specified in the manufacturer's model specification, form a part of this specification.

Air Force - Navy Aeronautical Bulletin

No. 343 Specifications and Standards Applicable to Aircraft Engines and Propellers; Use of

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. (5152) REQUIREMENTS

3.1 (5152) Contractor's instructions, specifications and drawings.-

3.1.1 (5152) Specifications.- Contractor's specifications shall include any tests found necessary to ensure calibration of components within specified environmental and operating conditions regardless of manufacturing processes employed.

3.1.2 (5152) Component calibration.- A complete set of calibration specifications for the calibrated components showing the bench setting limits used for acceptance shall be made available to the procuring activity prior to delivery of the first rocket engine.

3.1.3 (5152) Availability.- Copies of all contractor instructions, specifications, and drawings governing the inspection and testing of the rocket engine and its components shall be kept on file by the contractor and shall be supplied to the procuring activity upon request. When instructions, specifications, or drawings have been supplied to the procuring activity, all changes shall be supplied to the procuring activity upon release.

3.2 (5152) Acceptance test data.-

3.2.1 (5152) General.-

3.2.1.1 (5152) Dimensional units.- Unless otherwise specified, all dimensions shall be reported in the English gravitational system of units.

3.2.1.2 (5152) Corrections.- Performance characteristics shall be corrected in accordance with the contractor's data reduction method which shall be based on measurements obtained at a stabilized point during a short time-interval and which shall be acceptable to the procuring activity.

3.2.2 (5152) Log.- An Acceptance test log shall be prepared for each engine to include but not be limited to the reduced and derived data listed below.

3.2.2.1 (5152) Component test and inspection data files.- Data shall include test conditions and serial numbers of components tested, so arranged that summaries of tests on specific components by groups of serial numbers can be compiled.

3.2.2.2 (5152) Individual thrust chamber assembly.- Not applicable.

3.2.2.3 (5152) Rocket engine.-

(a) Weight test

(b) Static leakage test

(c) For each calibration test, a continuous record shall be taken of the original data for each engine.
  (1) Thrust
  (2) Chamber pressure
  (3) Fuel inlet pressure
  (4) Oxidizer inlet pressure
  (5) Fuel flow rate
  (6) Oxidizer flow rate
  (7) Barometric pressure and free air temperature (single reading)
  (8) Temperature of propellant at inlet to rocket engine.

(d) Additional tests.- (Use schedule for paragraph 3.2.2.3.1 (c).)

3.2.2.4 (5152) Reduced and derived data.-

3.2.2.4.1 (5152) Individual thrust chamber assembly.- Not applicable.

3.2.2.4.2 (5152) Rocket engine.- For each run the minimum data shall include the following:

(a) Instantaneous specific impulse
(b) Instantaneous mixture ratio
(c) Inlet temperature of propellant

3.2.2.5 (5152) Inspections.- Results of the specified rocket engine inspections shall be included in the Acceptance test log.

3.2.2.6 (5152) Disposition.- The Acceptance test log shall be retained by the contractor for two (2) years, and copies shall be furnished to the procuring activity upon request.

4. (5152) QUALITY ASSURANCE PROVISIONS

4.1 (5152) General.- Liquid propellant rocket engines, components, and test apparatus and the material entering into the manufacture of articles for fulfillment of contract requirements, shall be subject to inspection by authorized Government Inspectors. Complete specifications for all components shall be furnished to the procuring activity prior to beginning the Acceptance tests thereof. At convenient times prior to the tests and after the tests, the rocket engine and components shall be examined to determine if they conform to all requirements of the contract and specifications under which they were built. During the progress of tests, examinations may be made at the option of the procuring activity.

4.1.1 (5152) Test apparatus and procedures.- Schematic drawings and descriptions of all test apparatus, and outline diagrams showing points of measuring apparatus application, and test procedures or methods to be used shall be acceptable to the procuring activity.

4.1.1.1 (5152) Instrumentation calibration.- Each instrument and other measuring apparatus upon which the accuracy of test results depends shall be calibrated frequently enough to ensure attainment of steady state accuracy of plus or minus 3 percent of the specified value of the measurement, except where greater instrumentation accuracy is required to demonstrate the specification requirements. Calibration records shall be maintained and shall be made available to authorized representatives of the procuring activity or of the contractor upon request.

4.1.1.2 (5152) Automatic recording equipment.- Automatic recording equipment of adequate response shall be used to obtain data during transient conditions of rocket engine and component operation requiring the evaluation of time versus rocket engine variables.

4.1.3 (5152) Test temperatures.- Inspections and tests shall be conducted at room temperature as defined in paragraph (5152) 4.1.3.1 and at ambient pressure.

4.1.3.1 (5152) Room temperature.- Room temperature limits are as follows: (a) fuel at plus 32 to plus 80 F, (b) hydraulic fluid at plus 50 to plus 110 F, (c) ambient air and other test fluids at plus 10 to plus 110 F, except:

(1) When the test fluid boiling point is below plus 10 F, the fluid shall be allowed to remain at the temperature encountered under test conditions.

4.1.3.1 (Continued)
(5152)

(2) When the test fluid freezing point is above plus 10 F, the fluid shall be maintained at 10 F above its freezing point unless otherwise specified in the model specification.

4.1.3.2 (5152) Turbine drive fluid temperature.- Not applicable.

4.2 (5152) Acceptance tests.- Unless otherwise specified herein, the Acceptance test shall be conducted on each production rocket engine and shall consist of the tests specified under Schedule "A" or "B". All production rocket engines shall be acceptance-tested under Schedule "A" until such time as the penalty or parts replacement record warrants the use of Schedule "B" as mutually agreed upon by the contractor and the procuring activity. All subsequent rocket engines, except one out of a lot to be agreed upon between the contractor and the procuring activity, shall be acceptance-tested in accordance with Schedule "B". This rocket engine, selected at random by the Government Inspector, shall be acceptance-tested in accordance with Schedule "A". If the rocket engine does not include its own feed system, the rocket engine shall be tested with a test stand feed system providing inlet conditions as specified herein.

4.2.1 (5152) Rocket engine inspection before acceptance tests.- Each rocket engine shall be completely assembled in accordance with the contractor's drawings and this specification, then visually and dimensionally inspected before commencing the rocket engine tests.

4.2.2 (5152) Rocket engine tests.- Schedule "A".- Each rocket engine assembled for the inspection specified in paragraph (5152) 4.2.1 shall be subjected to the weight, static leakage, calibration, and such additional tests as required by paragraph (5152) 4.2.2.6.

4.2.2.1 (5152) Weight.- The dry rocket engine shall be weighed, and its weight shall not exceed the value specified in the model specification.

4.2.2.2 (5152) Radio interference.- Not applicable.

4.2.2.3 (5152) Static leakage.- All fluid systems of the rocket engine shall be tested for leakage by pressurizing individual systems to full operating pressures wherever practicable or to the highest pressures technically feasible or limited by recognized safety factors. The test pressures shall start at a low differential pressure and be increased at a uniform rate to the static leakage pressure. The maximum test pressure shall be maintained for a minimum of 2.0 minutes. Leakage, at any time during the test, shall not exceed that specified in paragraph 3.3.9.5.

4.2.2.4 (5152) Calibration.- The rocket engine shall be operated for a limited duration at the tank-fed conditions and approximate pump-fed conditions. The sequence of operation shall be in accordance with the applicable parts of paragraphs 3.3.5 and 3.3.6. During a part of a calibration run the thrust chamber shall be gimbaled at a slow rate through a total included angle of 140 degrees in pitch and a total included angle of 50 degrees in yaw in lieu of demonstrating the full travel limits of paragraph 3.6.6, due to test facility limitations.

4.2.2.5 (5152) Rocket engine component tests.- All component parts of the rocket engine shall be tested to demonstrate conformance with the contractor's drawings and specifications.

4.2.2.5.1 (5152) Individual thrust chamber assembly tests.-

4.2.2.5.1.1 (5152) Flow tests.- Each individual thrust chamber assembly shall be given a cooling jacket flow test and an injector flow test using the propellants specified in the model specification or an alternate test fluid approved by the procuring activity in accordance with approved test procedures. The pressure drops, at rated flow conditions, shall be within the limits specified in the calibration curves called for in paragraph 3.2.1 (5152).

5.2.2.5.1.2 (5152) Firing tests.- Calibration tests performed under paragraph (5152) 4.2.2.4 shall accomplish the requirements for individual thrust chamber firing tests.

4.2.2.5.2 (5152) Gas generator test.- Not applicable.

4.2.2.6 (5152) Additional tests.- Additional tests, for the purpose of testing special features of the rocket engine and propellants, shall be as required by mutual agreement of the procuring activity and the contractor. These tests shall not, in general, increase the total running time accumulated during the acceptance test.

4.2.3 (5152) Rocket engine and component tests.- Schedule "B".- Schedule "B" shall consist of the test requirements agreed upon between the procuring activity and contractor for the rocket engine and components involved.

4.2.4 (5152) Acceptance conditions.- Acceptance of the rocket engine shall be predicated on the maintenance of tank-fed parameters within the limits specified in Table I of paragraph 3.3.2 with the exception that an acceptance test mixture ratio shall be within 1.7 to 1.9 at standard engine inlet conditions. Prior to delivery the rocket engine shall be reorificed without additional testing to target the nominal mixture ratio and thrust of the tank-fed rating of Table I based upon the results of the acceptance test(s). The average specific impulse of the engine, determined from the acceptance runs, shall be above the specification minimum. An individual test value below the minimum specific impulse but within 2 percent of the average shall be acceptable. The pump-fed ratings shall not be construed as acceptance criteria.

4.2.5 (5152) Rocket engine inspection after test.- Upon completion of the acceptance tests, the rocket engine shall be subject to a complete visual inspection by the Government Inspector, without disassembly, except where data or circumstances indicate that defective parts may exist; the disassembly may be accomplished as requested by the Government Inspector. Defective parts shall be replaced by approved parts, and a suitable penalty test may be made at the discretion of the Government Inspector if the replaced parts failed under unusual circumstances or affect performance characteristics of the engine.

4.2.5.1 (5152) Rocket engine penalty test.- The maximum penalty test shall consist of a repetition of the test runs outlined under paragraph (5152) 4.2.2. Preliminary runs may be conducted prior to the penalty test.

4.2.5.2 (5152) Rocket engine inspection after penalty test.- Upon completion of the acceptance test the rocket engine shall be subjected to a complete visual inspection by the Government Inspector without disassembly except where data or circumstances indicate that defective parts may exist; then, disassembly may be accomplished as requested by the Government Inspector. Defective parts shall be replaced by approved parts and a suitable penalty test may be made at the discretion of the Government Inspector if replaced parts affect operational characteristics of the engine.

4.2.5.3 (5152) Rocket engine reassembly test.- Not applicable.

4.2.6 (5152) Rejection and retest.- Whenever, in the opinion of the inspector, there is evidence of malfunction or that the rocket engine is not meeting performance rating requirements, the difficulty shall be investigated and its cause corrected to the satisfaction of the inspector before the test is continued. At the option of the inspector, the portion of the test in which the difficulty was encountered shall be repeated.

4.2.6.1 (5152) Radio interference.- Not applicable.

4.2.6.2 (5152) Maximum running time.- The rocket engine shall stand rejected whenever the total running time accumulated during preliminary runs and the tests specified herein exceeds three (3) times rated duration. Parts and accessories from rejected rocket engines may be reused if such items can be reconditioned to meet the requirements for new parts. The inspector shall be furnished full particulars of previous rocket engine rejection when such items are resubmitted for inspection.

5. (5152) PREPARATION FOR DELIVERY

5.1 (5152) Not applicable to this specification

6. (5152) NOTES

6.1 (5152) Symbols and definitions.- The symbols and terms used in this specification and the applicable definitions will be as specified in this model specification.

4.2.4.1 Miscellaneous inspection tests.-

4.2.4.1.1 Material tests.- Samples of materials used in the rocket engine shall be selected and tested as specified in the quality control procedures established by the contractor.

4.2.4.1.2 Magnetic inspection.- The following parts shall be subjected to magnetic particles inspection in accordance with Specification MIL-I-6868 or AMS 2640, if made of magnetic material.

(a) All highly stressed parts including threaded fastenings
(b) Vibration or friction damper springs.
(c) All gears.

4.2.4.1.3 Fluorescent penetrant inspection.- All highly stressed non-magnetic parts shall be subjected to fluorescent penetrant inspection in accordance with Specification MIL-I-6868 or AMS 2645.

4.2.4.1.3.1 Very bulky and intricately shaped parts may be hydrostatically tested by the contractor's approved method in lieu of fluorescent penetrant testing, when specifically approved by the procuring activity's representative.

4.2.4.1.4 Utility parts.- Commercial, AN, and MS standard parts such as cotter pins, washers, etc., and similar low-stressed parts are not required to be inspected by the magnetic or fluorescent penetrant method.

4.2.4.1.4.1 Antifriction bearings.- Assembled ball or roller bearings shall not be magnetically inspected.

4.2.4.1.5 Radiographic or ultrasonic inspection.- Highly stressed magnesium and aluminum castings shall be subjected to radiographic or ultrasonic inspection for defects or soundness to a degree of inspection on each article as agreed upon between the contractor and the procuring activity.

4.2.4.1.5.1 Radiographic inspection.- Radiographic inspection materials shall be in accordance with Specification MIL-I-6865. Laboratories performing radiographic inspection shall be certified in accordance with Specification MIL-X-6141.

4.2.4.1.6 Certification of operators.- All operators performing fusion welding shall be certified.

5. PREPARATION FOR DELIVERY

5.1 Application.- The requirements of Section 5 apply only to direct purchases by or direct shipment to the Government.

5.2 Storage, shipment, and delivery.- Preparation for storage and shipment, when required by contract shall be in accordance with the applicable specifications and drawings of paragraph 3.5, Drawings and data, utilizing government-approved containers unless otherwise directed by the contracting officer or his authorized representative.

6. NOTES

6.1 Intended use.- The liquid propellant rocket engines covered by this specification are intended for remotely launched missile application.

6.2 Symbols and definitions.- The symbols used in the model specifications, and the applicable definitions, will be as specified in Specification MIL-E-5150 except as follows:

6.2.1 Definitions.-

6.2.1.1 Government.- The term "Government" as used in this specification shall be interpreted to mean the procuring activities of the Department of Defense.

6.2.1.2 Procuring activity.- The procuring activity is the activity which negotiates the rocket engine contract.

6.2.1.3 Using service.- The using service is the activity whose model dash number has been assigned to the rocket engine in accordance with ANA Bulletin No. 352.

6.2.1.4 Rating.- A value of some characteristic of performance as specified in the model specification.

6.2.1.5 Estimate.- A predicted range of characteristics of performance as specified in the model specification.

6.2.1.6 Accessories.- Accessories are items of equipment required for vehicle operation.

6.2.1.7 Assembly, pump and drive.- Not applicable.

6.2.1.8 Assembly, thrust chamber.- The thrust chamber assembly (TCA) is composed of the thrust chamber, and any other directly associated parts.

6.2.1.9 Chamber, combustion.- The combustion chamber is the enclosed volume between the injector face and the throat of the nozzle.

6.2.1.10 Chamber, thrust.- The thrust chamber is that component of rocket engine which produces thrust and includes the expansion nozzle and propellant injector. (Propellant valves are included if they are an integral part of the injector.)

6.2.1.11 Coefficient, thrust.- The thrust coefficient (C_F) is the quotient of the thrust in pounds divided by the product of the nominal chamber pressure in pounds per square inch absolute and the throat area in square inches.

6.2.1.12 Components, engine.- Engine components are items of equipment furnished as parts of the engine which are required for engine operation.

6.2.1.13 Consumption, specific propellant.- The specific propellant consumption (SPC) is the total propellant consumption rate, in pounds per second, divided by the thrust produced, in pounds.

6.2.1.14 Conditions, standard.- Standard conditions are the values of air temperature and pressure given in Appendix A, Proposed Extension to ICAO Standard Atmosphere, Model 1b, Using Variable Gravity, Molecular-Scale Temperature and Geopotential Altitude, AFRC-ARDC, dated April 1955.

6.2.1.15 Cutoff.- Cutoff is the time of propellant flow cessation through the thrust chamber propellant shutoff valve(s).

6.2.1.16 Drive, pump.- Not applicable.

6.2.1.17 Duration.- The duration is the total firing time of one operational cycle (seconds).

6.2.1.18 Efficiency, over-all pump.- Not applicable.

6.2.1.19 Efficiency, turbine mechanical.- Not applicable.

6.2.1.20 Head, net, positive suction.- Not applicable.

6.2.1.21 Impulse, effective.- Effective impulse is the area under the thrust-time curve between the two 90-percent-of-rated thrust points.

6.2.1.22 Impulse, effective specific.- The effective specific impulse is the effective impulse divided by the sum of the weights of propellants used during the intervals between the two 90-percent-of-rated thrust point.

6.2.1.23 Impulse, mean specific.- The mean specific impulse is the total impulse divided by the total weight of propellant(s) consumed.

6.2.1.24 Impulse, instantaneous specific.- The instantaneous specific impulse is the instantaneous thrust produced, in pounds, divided by the total instantaneous propellant consumption rate, in pounds per second.

6.2.1.25 Impulse, total.- The total impulse (I_t) is the area under the thrust-time curve.

6.2.1.26 Length, characteristic.- The characteristic length (L*) is the combustion chamber volume in cubic inches divided by the throat area in square inches.

$$L^* = \frac{V_c}{A_t} \text{ inches}$$

6.2.1.27 Points, 90-percent-of-rated thrust.- The 90-percent-of-rated thrust points are the time points during thrust increase and decrease between which the thrust is stabilized at greater than 90 percent of rated value.

6.2.1.28 Pressure, effective chamber.- The effective chamber pressure is the area under chamber pressure-time curve between the two 90-percent-of-rated thrust points divided by the time interval between these points.

6.2.1.29 Pressure, mean chamber.- The mean chamber pressure is the area under the chamber pressure-time curve divided by the duration.

6.2.1.30 Pressure, nominal working.- The nominal working pressure is a maximum pressure to which the component is subjected under steady state condition.

6.2.1.31 Pressure, burst.- Burst pressure is the pressure which, once applied to an item, results in exceeding its ultimate strength.

6.2.1.32 Pressure, proof.- Proof pressure is the test pressure to which an item is subjected without deformation adversely affecting rocket engine operation, or permanent set. Proof pressure is 1.5 times the nominal working pressure for aircraft- and vehicle-launched rocket engines and 1.2 times the nominal working pressure for remotely launched missile rocket engines plus the difference between nominal working pressure and maximum transient pressure.

6.2.1.33 Pressure, maximum transient.- The maximum transient pressure is the significant maximum pressure to which an item is subjected under any operating condition.

6.2.1.34 Propellant, referee.- A propellant incorporating the most adverse constituents of the specification propellant or which specifies propellant constituents after a 2-year storage period.

6.2.1.35 Ratio, effective mixture.- The effective mixture ratio is the weight of the oxidizer used between the two 90-percent-of-rated-thrust points divided by the weight of the fuel used between the two 90-percent-of-rated-thrust points.

6.2.1.36 Ratio, mean mixture.- The mean mixture ratio (W_o/W_f) is the total weight of oxidizer consumed divided by the total weight of fuel consumed.

6.2.1.37 Ratio, instantaneous mixture.- The instantaneous mixture ratio (r_m) is the ratio of the oxidizer flow rate to the fuel flow rate.

6.2.1.38 Rocket engine.- A rocket engine consists of all components specified in the model specification.

6.2.1.39 Rocket engine, aircraft.- "Aircraft" denotes a propulsion rocket engine for an inhabited flight vehicle.

6.2.1.40 Rocket engine, vehicle-launched missile.- "Vehicle-launched" operated prior to or during launching from an inhabited vehicle.

6.2.1.41 Rocket engine, remotely launched missile.- "Remotely launched" denotes a propulsion rocket engine for a missile other than that specified in paragraph 6.2.1.40.

6.2.1.42 Thrust.- Thrust (F) is the reactive force of the rocket engine during operation.

6.2.1.43 Thrust, effective.- The effective thrust is the effective impulse divided by the time interval between the two 90-percent-of-rated thrust points.

6.2.1.44 Thrust, mean.- The mean thrust is the total impulse divided by the duration.

6.2.1.45 Velocity, characteristic.- The characteristic velocity (c*) is the product of throat area in square inches, chamber pressure in pounds per square inch absolute, and nominal acceleration due to gravity (32.174) in feet per second divided by rate of propellant flow in pounds per second.

6.2.1.46 Effective duration.- The effective duration is the time interval between the two 90-percent-of-rated thrust points, as defined in paragraph 6.2.1.27 of Specification MIL-E-5150A.

6.2.1.47 Nominal chamber pressure.- The nominal chamber pressure is the nozzle stagnation pressure of the thrust chamber. Nozzle stagnation pressure is computed from a knowledge of measured values of injector end static pressure. Based upon presently used combustion and fluid flow theories, the ratio of injector end pressure to nozzle stagnation pressure is 1.025.

6.2.1.48 Engine performance test.- An engine performance test is a test of sufficient duration for the engine and recording equipment to reach steady state conditions for a period not less than 3 seconds and in which time all required performance measurements are obtained.

6.2.1.49 Critical components.- Critical components are the thrust chamber, injector, and main propellant orifices.

6.2.1.50 MD number identification.- MD number identification (end item markings) will be formulated and interpreted as shown in the following table:

END ITEM MARKINGS

EXAMPLE	MD NUMBERED CHANGES INCORPORATED	ITEM MARKING
1	1, 2, 3, 4	MD4
2	3	MDx3
3	1, 2, 3, 5, 8	MD3x5x8
4	3, 4, 5, 7,	MDx35x7
5	1, 2, 3, 5, 6, 7, 8, 9, 10, 12	MD3x510x12
6	EXAMPLE 4 AFTER INCORPORATION OF CHANGES 2 & 6	MDx27

6.2.2 Symbols.- Symbols used in this specification are defined as follows:

SYMBOL	QUANTITY	UNIT
c*	Characteristic velocity	ft/sec
P_c	Chamber pressure	psia
A_t	Throat area	in^2
I_{sp}	Specific impulse	sec
$\dot{W}$	Fluid flow rate	lb/sec
C_F	Thrust coefficient	$(= \frac{F}{P_c \quad A_t})$
F	Thrust	lb
L*	Characteristic length	in. $(= \frac{V_c}{A_t})$
V_c	Combustion chamber volume	in^3

6.3 Rocket engine mockup procedure.- Official examination of the mockup of new types of engine will be conducted in accordance with the provisions of ANA Bulletin No. 406.

6.4 Design and installation criteria.- Design criteria and recommended practices for the guidance of design shall be as set forth in ANA Bulletin No. 428.

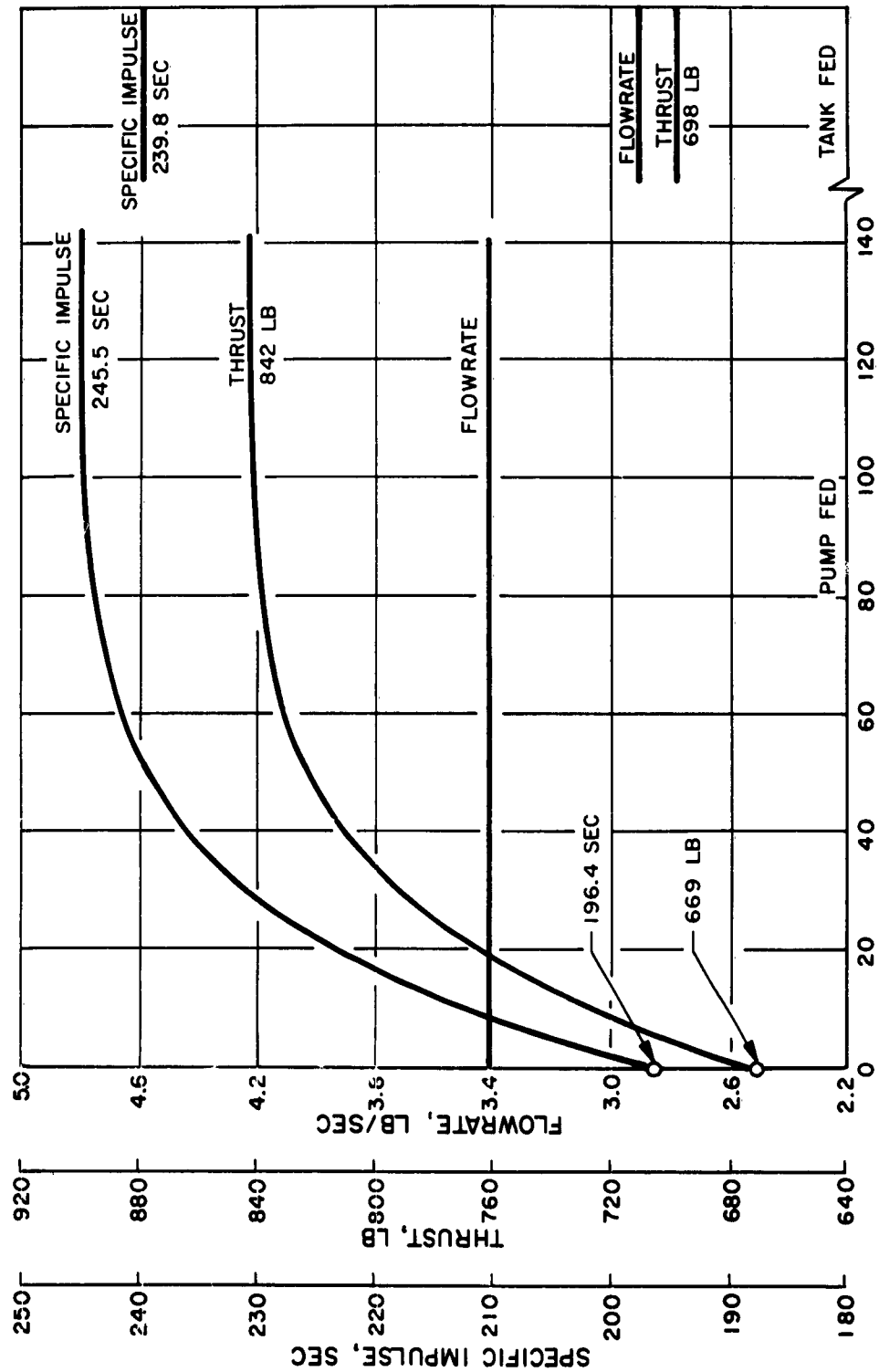

FIGURE 1
ESTIMATED NOMINAL ALTITUDE PERFORMANCE
YLR-101-NA-15

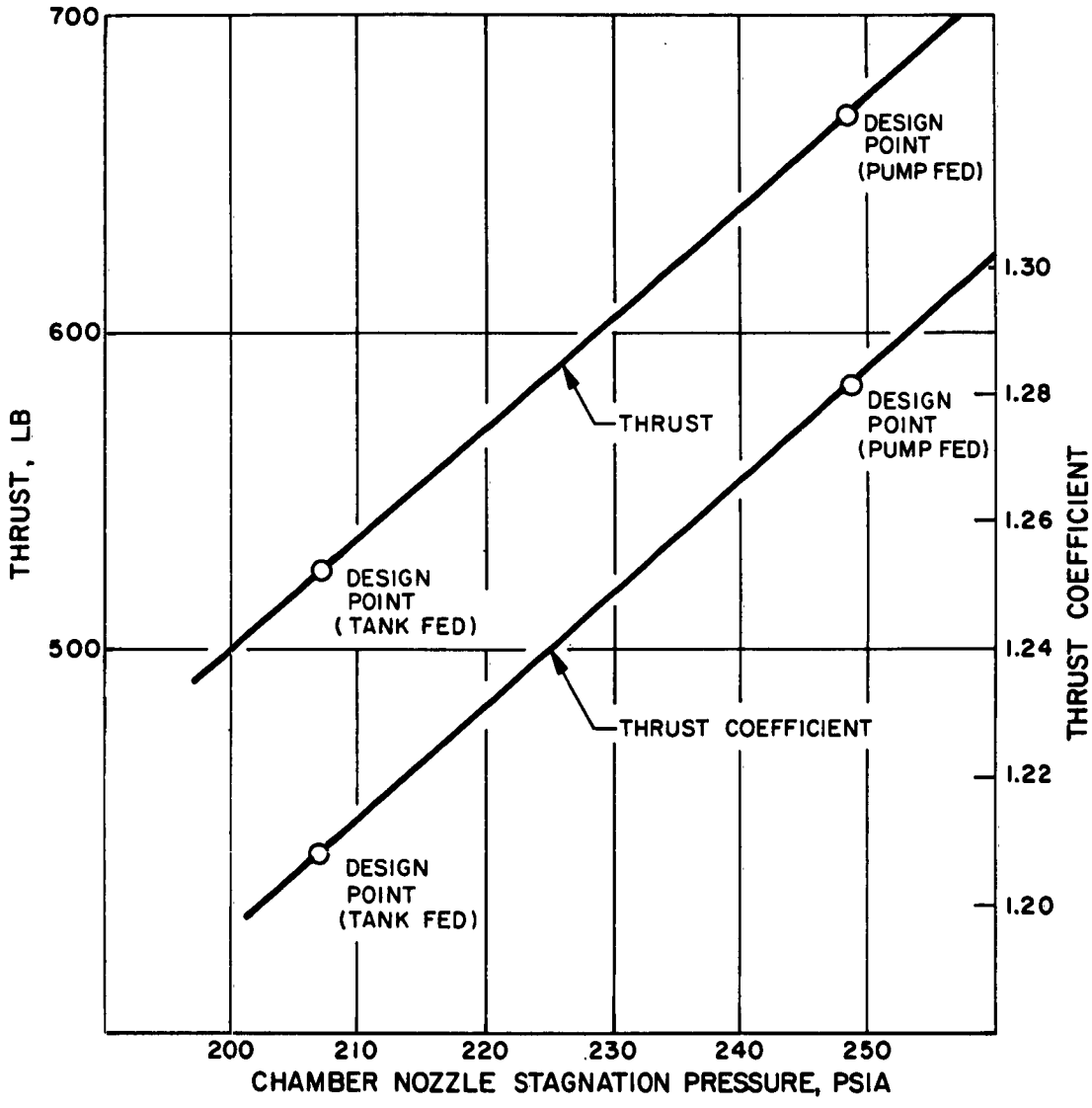

FIGURE 2

ESTIMATED SEA - LEVEL THRUST AND THRUST COEFFICIENT
VERSUS
CHAMBER NOZZLE STAGNATION PRESSURE

YLR 101-NA-15 THRUST CHAMBER
(NOZZLE EXPANSION AREA RATIO 5.6:1)

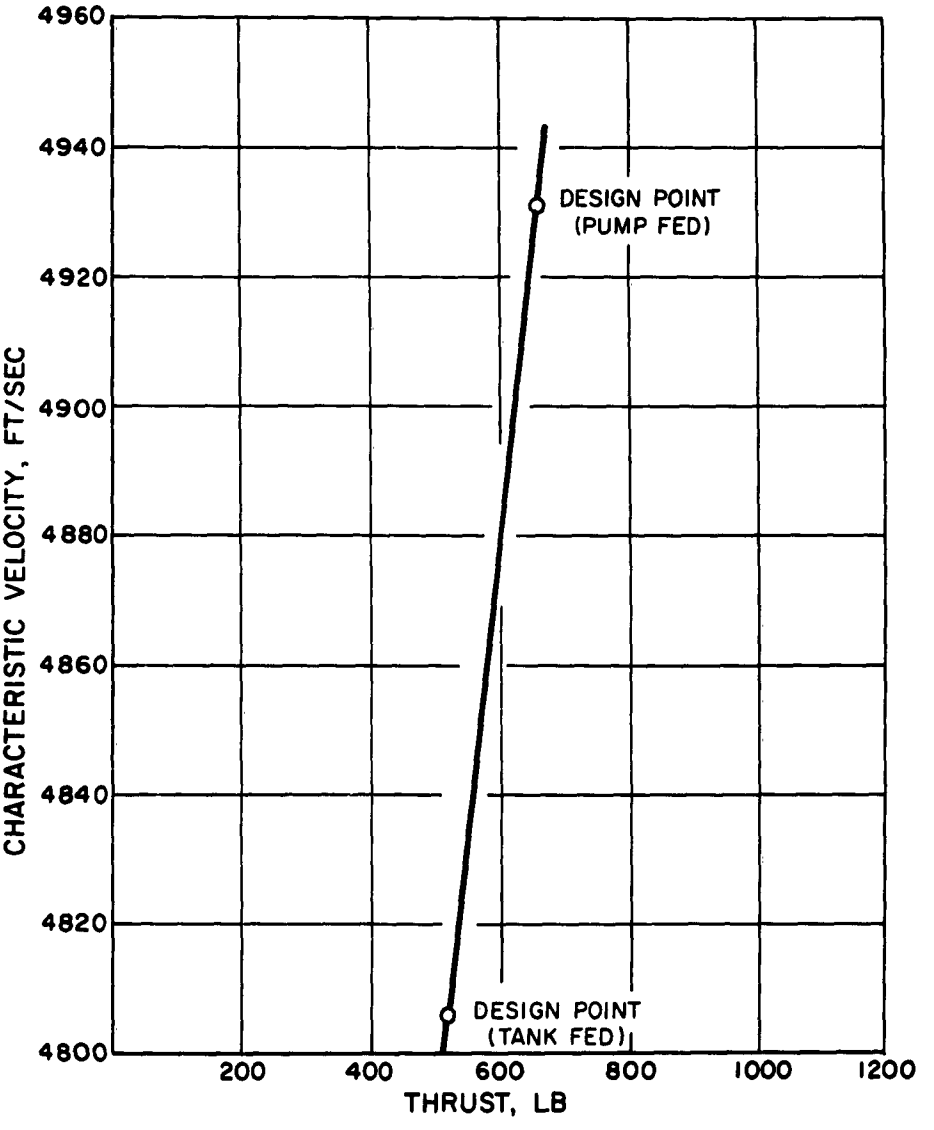

FIGURE 3

ESTIMATED CHARACTERISTIC VELOCITY
VERSUS
SEA LEVEL THRUST

YLR 101-NA-15 THRUST CHAMBER

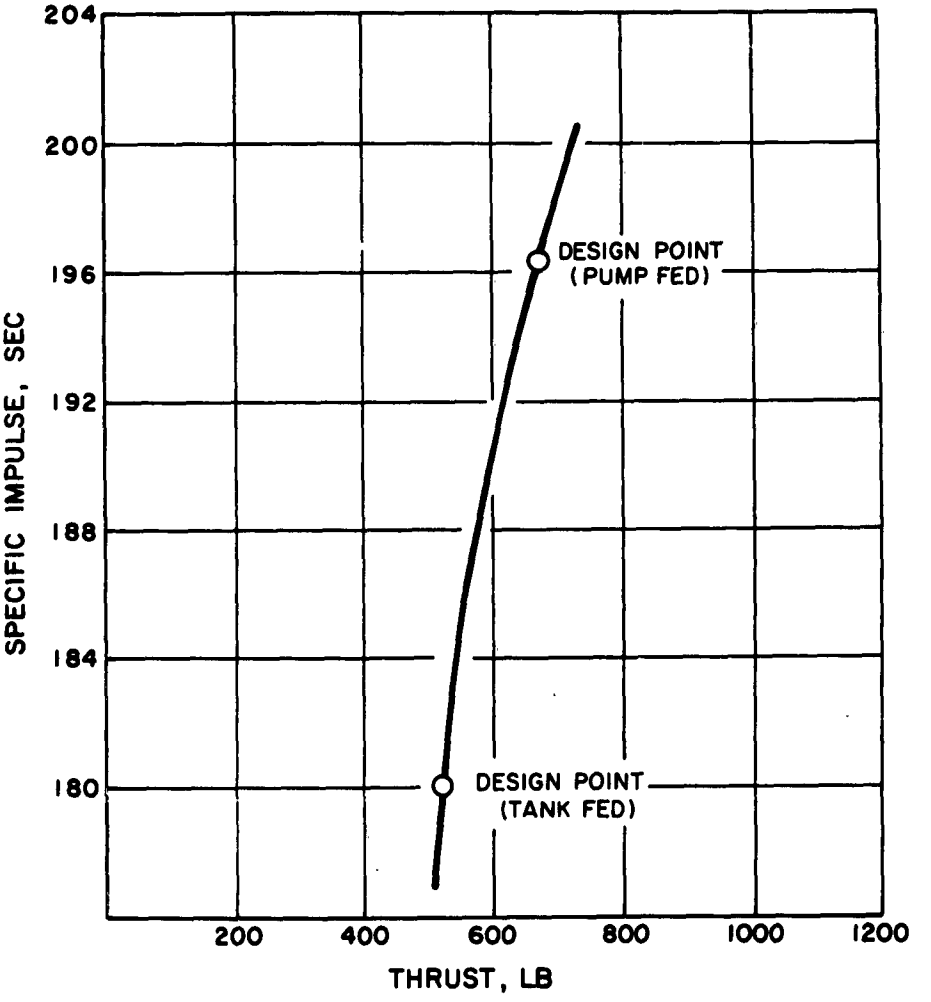

FIGURE 4

ESTIMATED SEA LEVEL SPECIFIC IMPULSE
VS
THRUST

YLR 101-NA-15 THRUST CHAMBER

NOTE: ALL REFERENCES TO "MAIN ENGINES" OR "MAIN VALVE" REFER TO THE YLR89-NA-7 AND THE YLR105-NA-7.

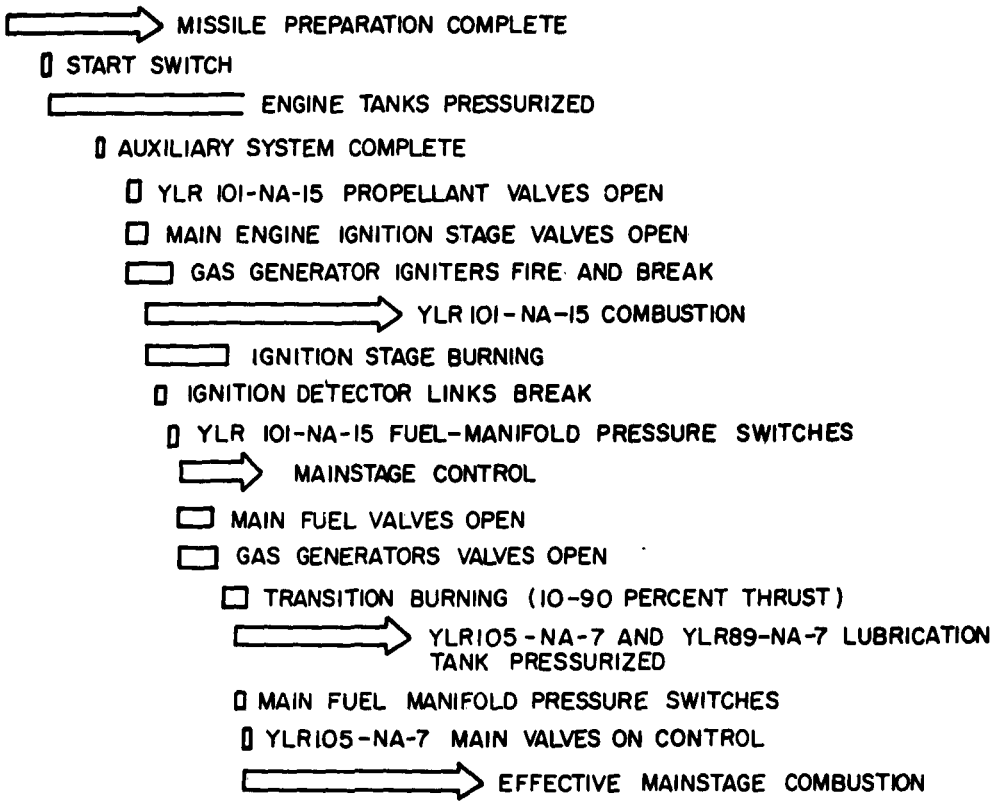

FIGURE 5

STARTING SEQUENCE
YLR101-NA-15, WHEN OPERATED WITH
YLR89-NA-7 AND YLR105-NA-7

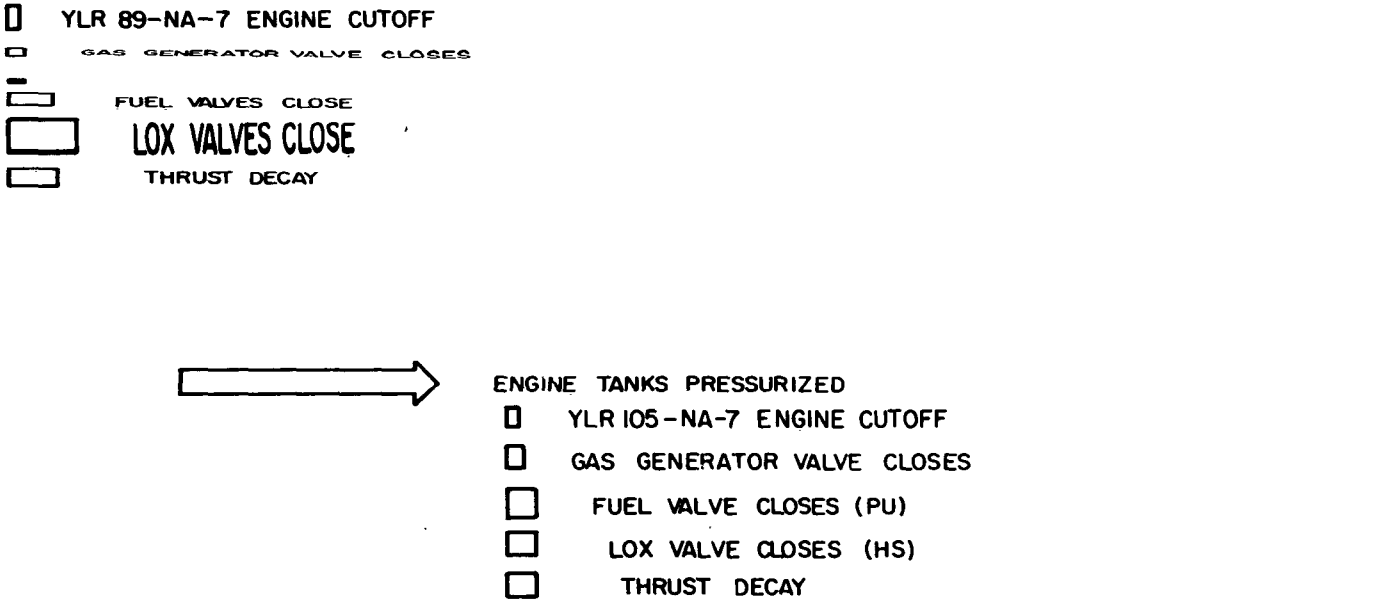

FIGURE 6

CUTOFF SEQUENCE
YLR101-NA-15, WHEN OPERATED WITH
YLR89-NA-7 AND YLR105-NA-7

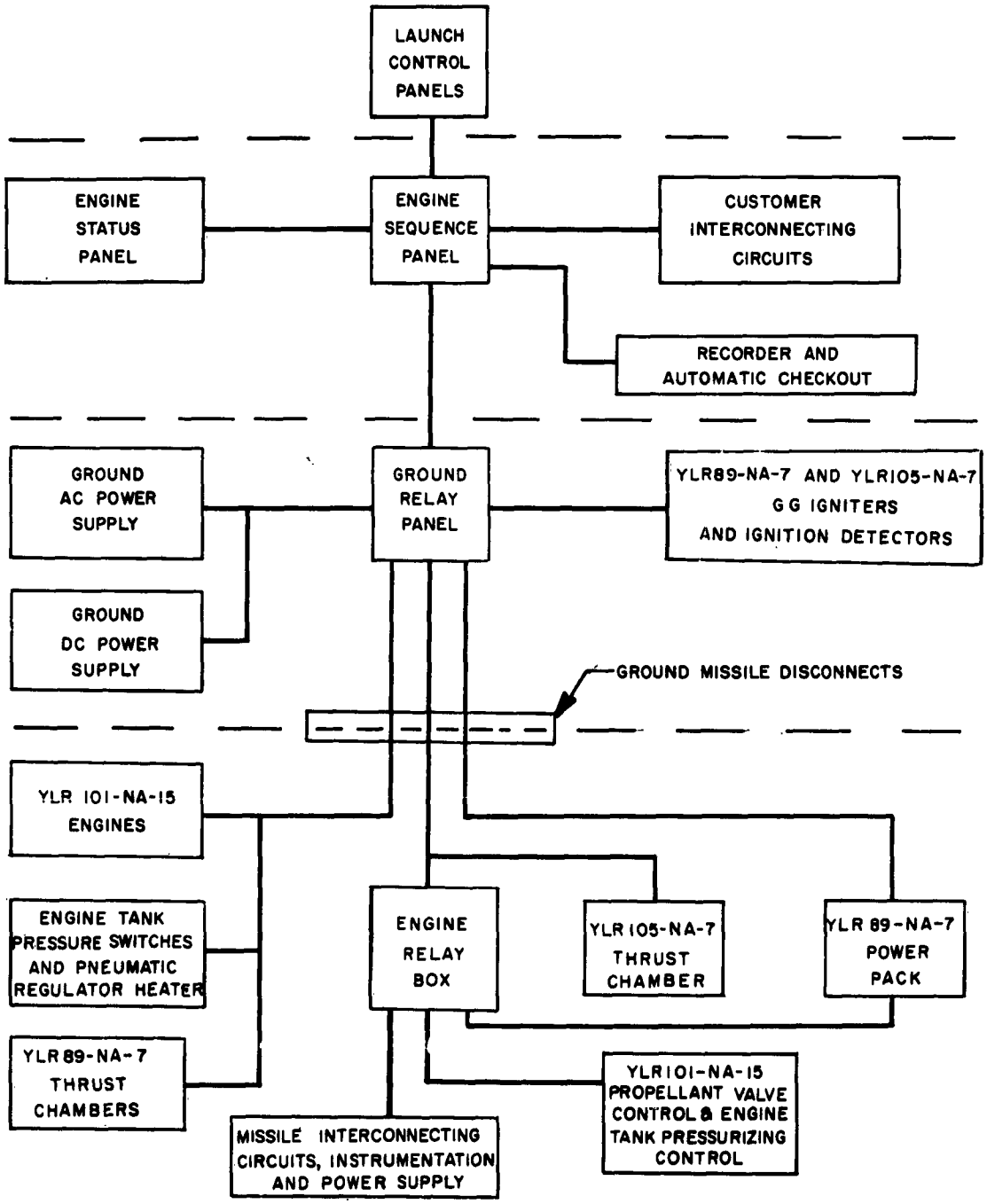

FIGURE 7 : POWER CONTROL ARRANGEMENT, YLR101-NA-15, WHEN OPERATED WITH YLR89-NA7 AND YLR105-NA-7

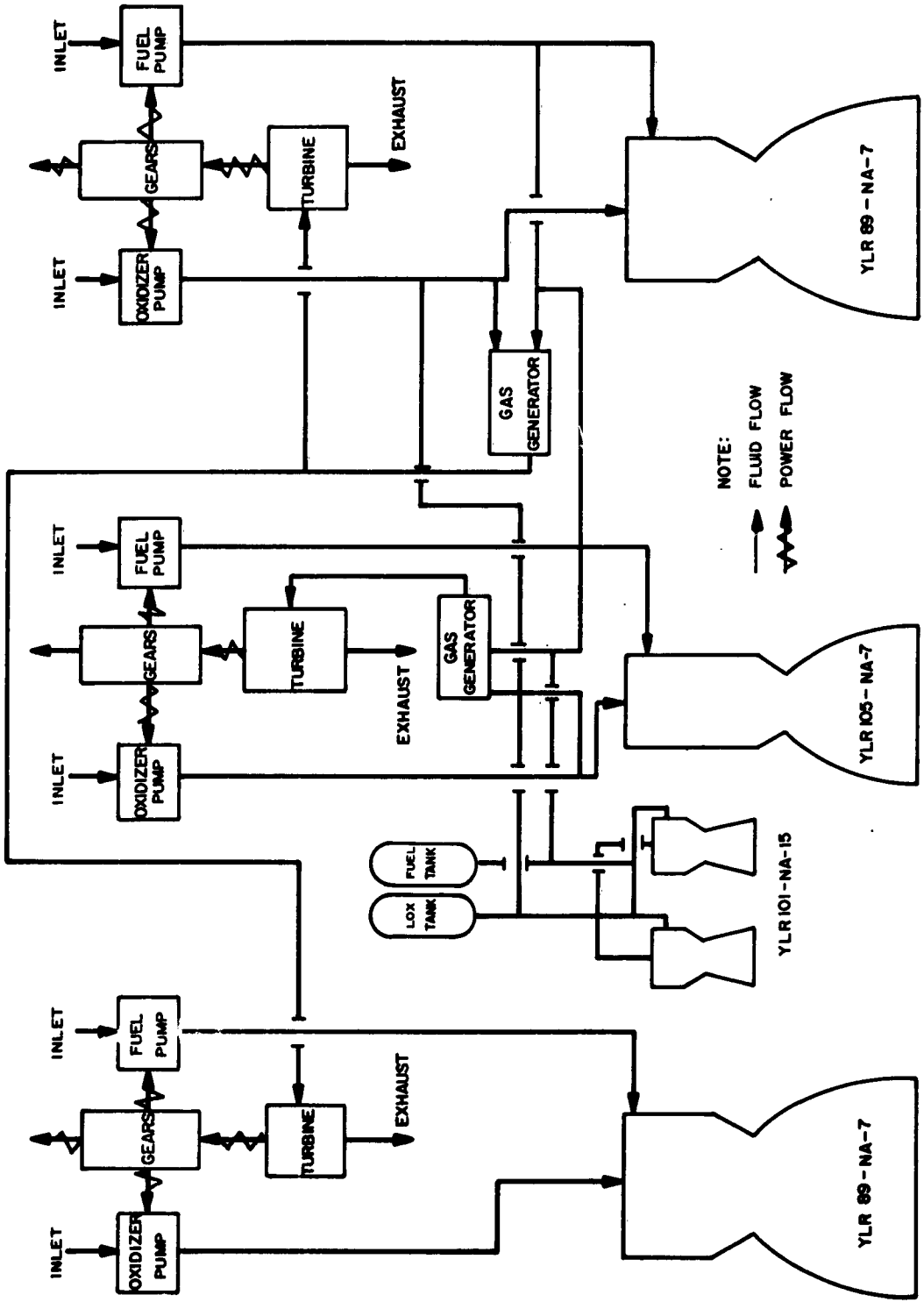

FIGURE 8
SCHEMATIC ROCKET ENGINE FLOW DIAGRAM,
YLR101-NA-15, WHEN OPERATED WITH YLR89-NA-7 AND YLR105-NA-7

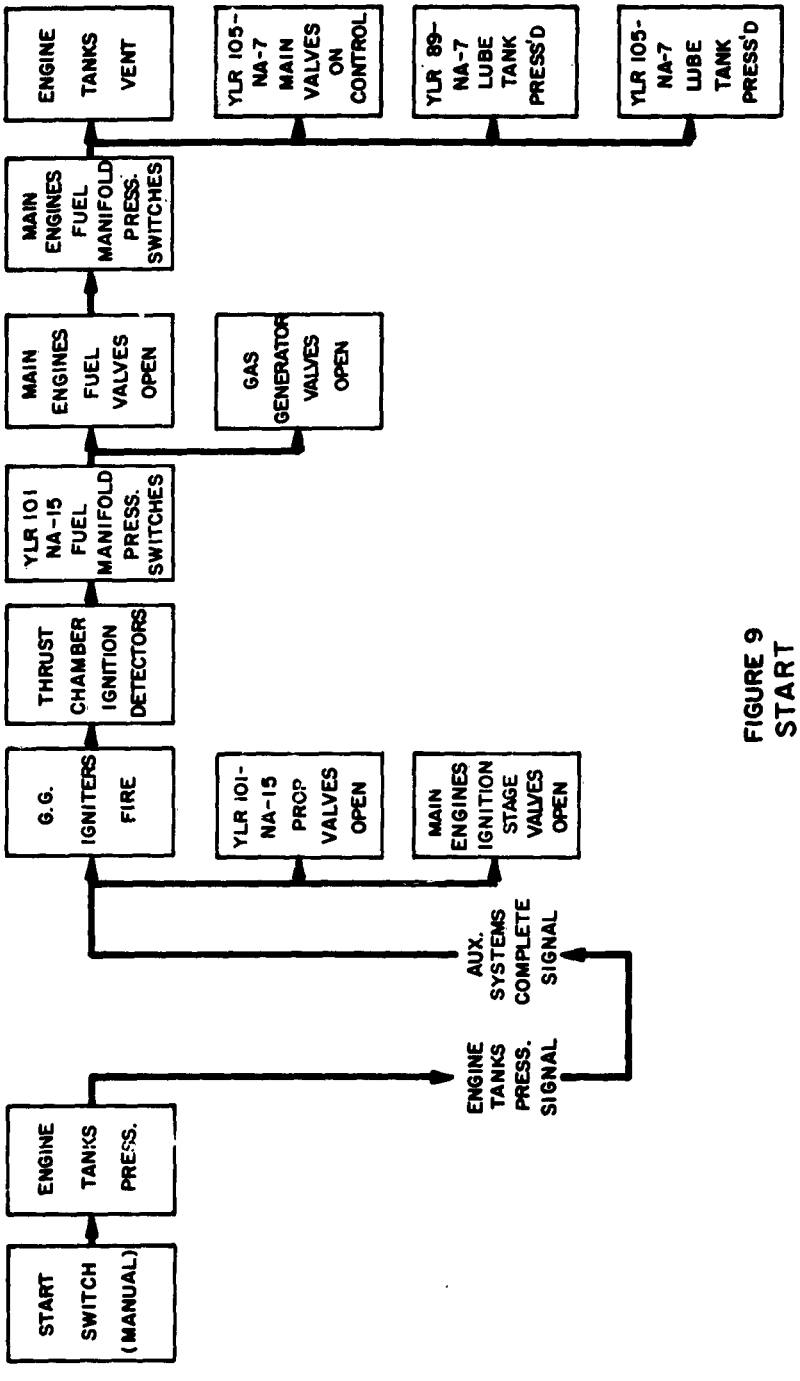

FIGURE 9
START
POWER CONTROL
INTERRELATION WITH ROCKET
ENGINE, FUNCTIONAL BLOCK DIAGRAM
OF YLR01-NA-15 WHEN OPERATED WITH YLR89-NA-7 AND YLR105-NA-7

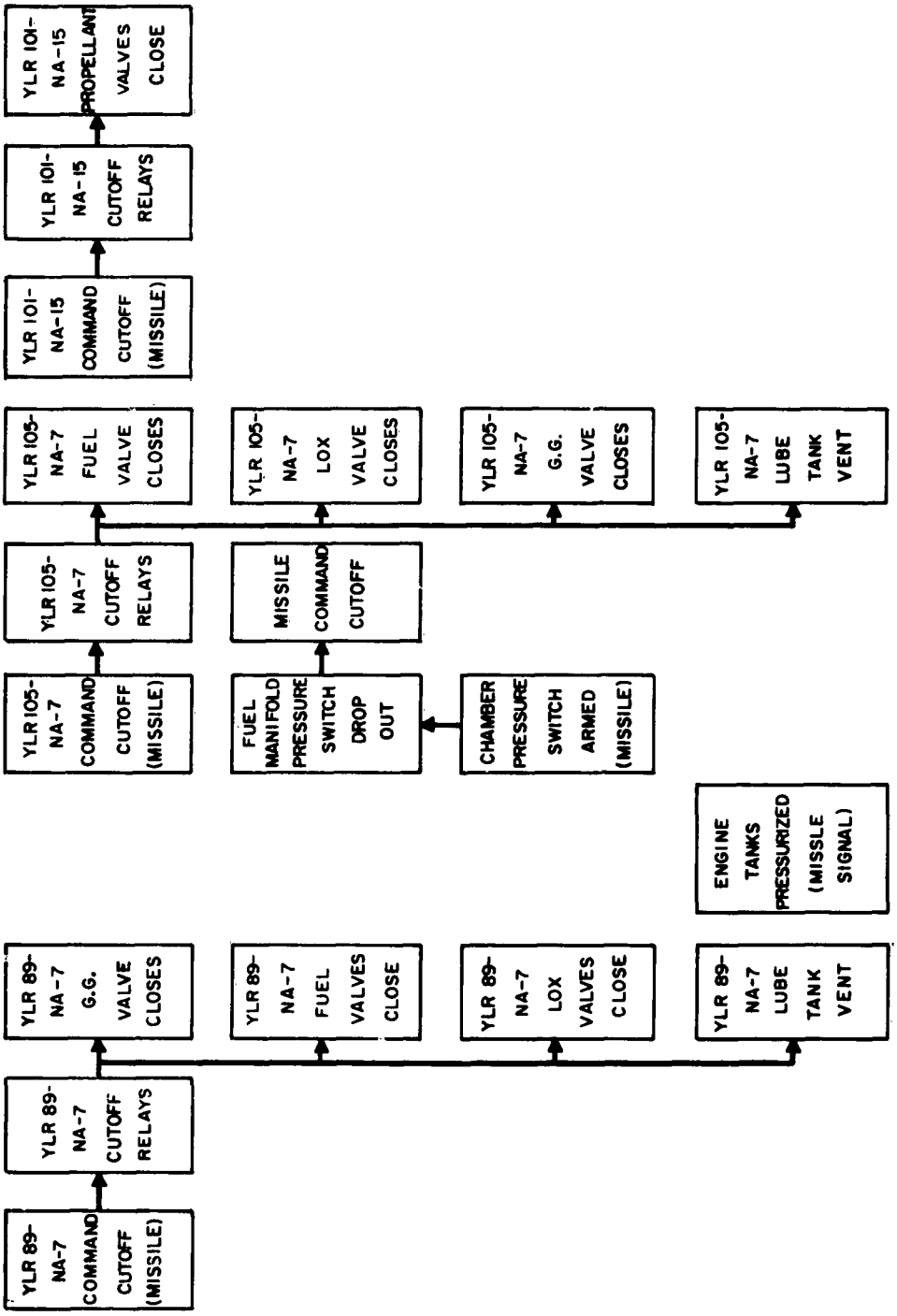

FIGURE 10
SHUTDOWN POWER CONTROL INTERRELATION WITH ROCKET ENGINE, FUNCTIONAL BLOCK DIAGRAM
OF YLR101-NA-15 WHEN OPERATED WITH YLR89-NA-7 AND YLR105-NA-7

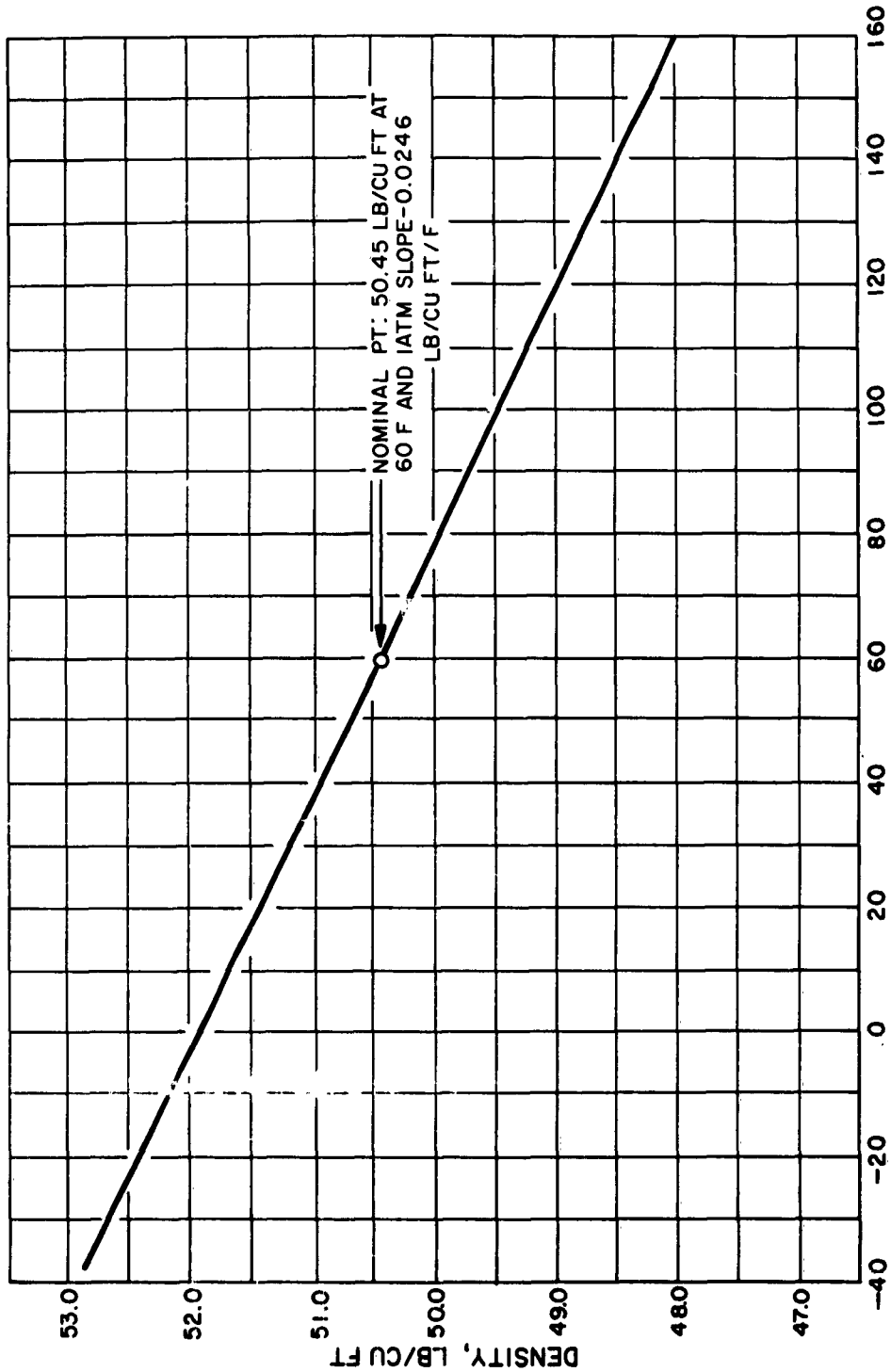

FIGURE II
FUEL (RP-1) DENSITY
VS
TEMPERATURE

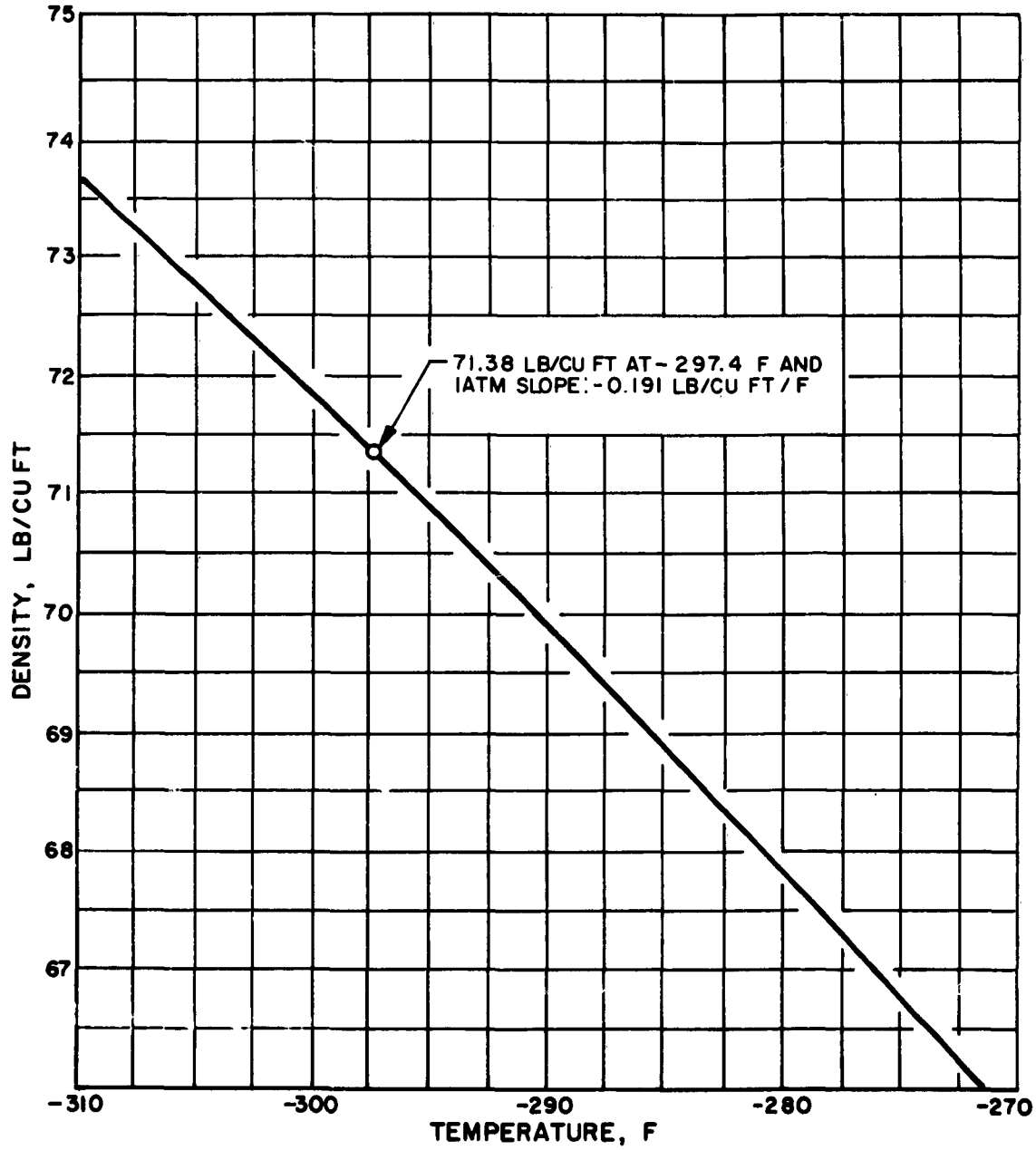

FIGURE 12
LIQUID OXYGEN DENSITY
VS
TEMPERATURE